De la meteorología a la hidrología: Sistemas de previsión de “peligro” hidrológico a escala Europea

Prof. Daniel Sempere Torres
Centre de Recerca Aplicada en Hidrometeorologia
Universitat Politècnica de Catalunya
Barcelona

Genova (Italy) on 4th of November 2011

after > 300 mm of accumulated rain in less than 24h

Why precipitation nowcasting is crucial in hydrology?

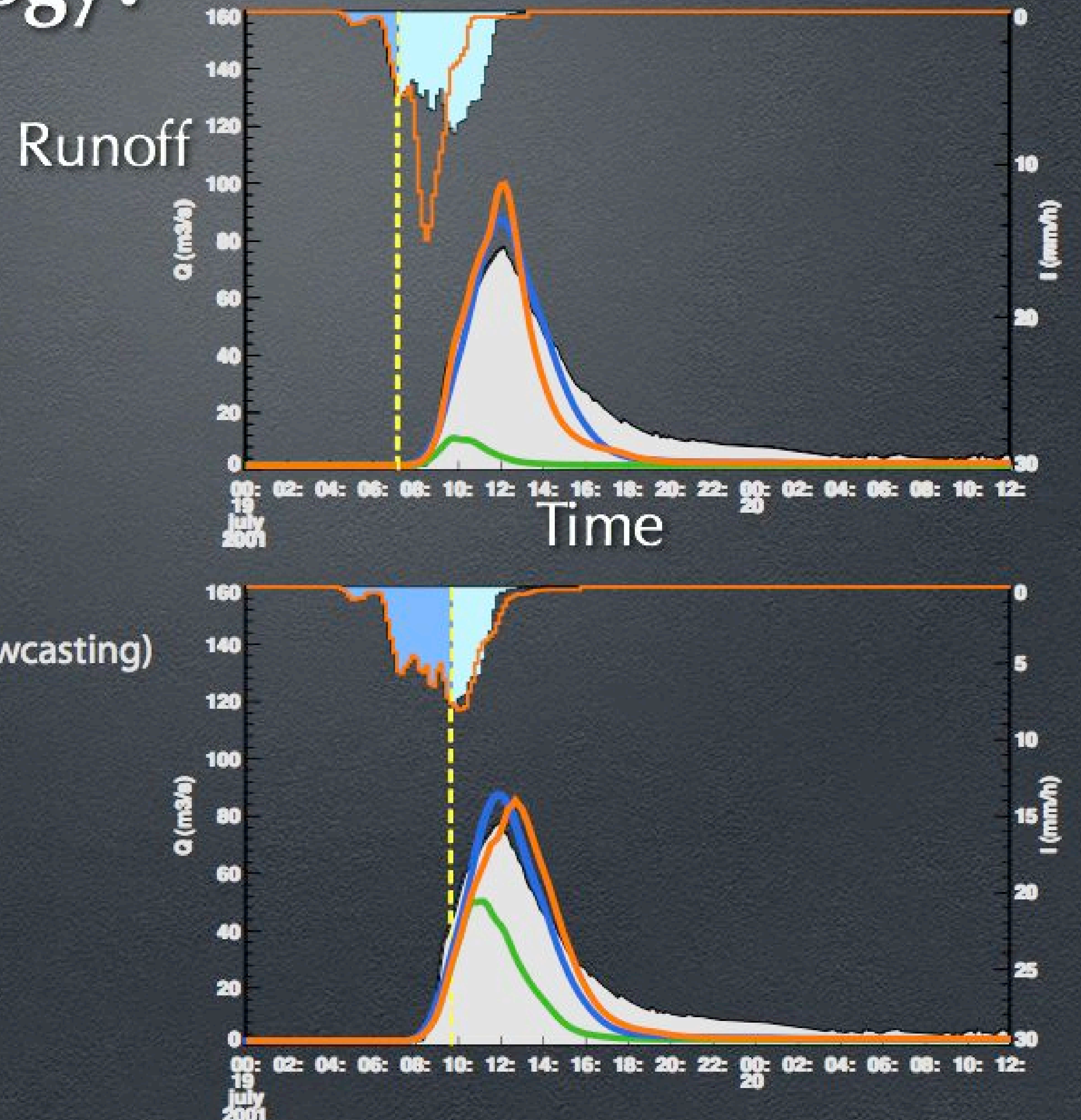
forecasting example using radar
(Besòs river at Montcada, July 2001)

observed runoff

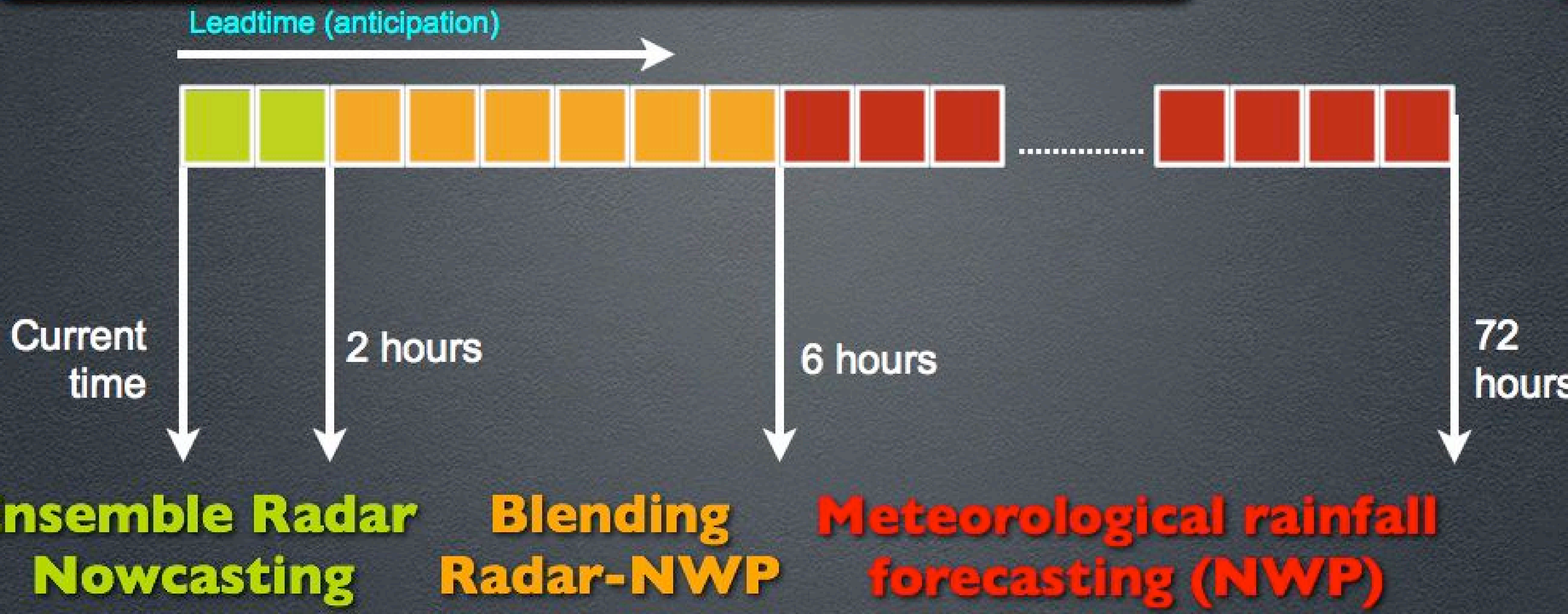
model

model (without QPF)

model (with radar based nowcasting)

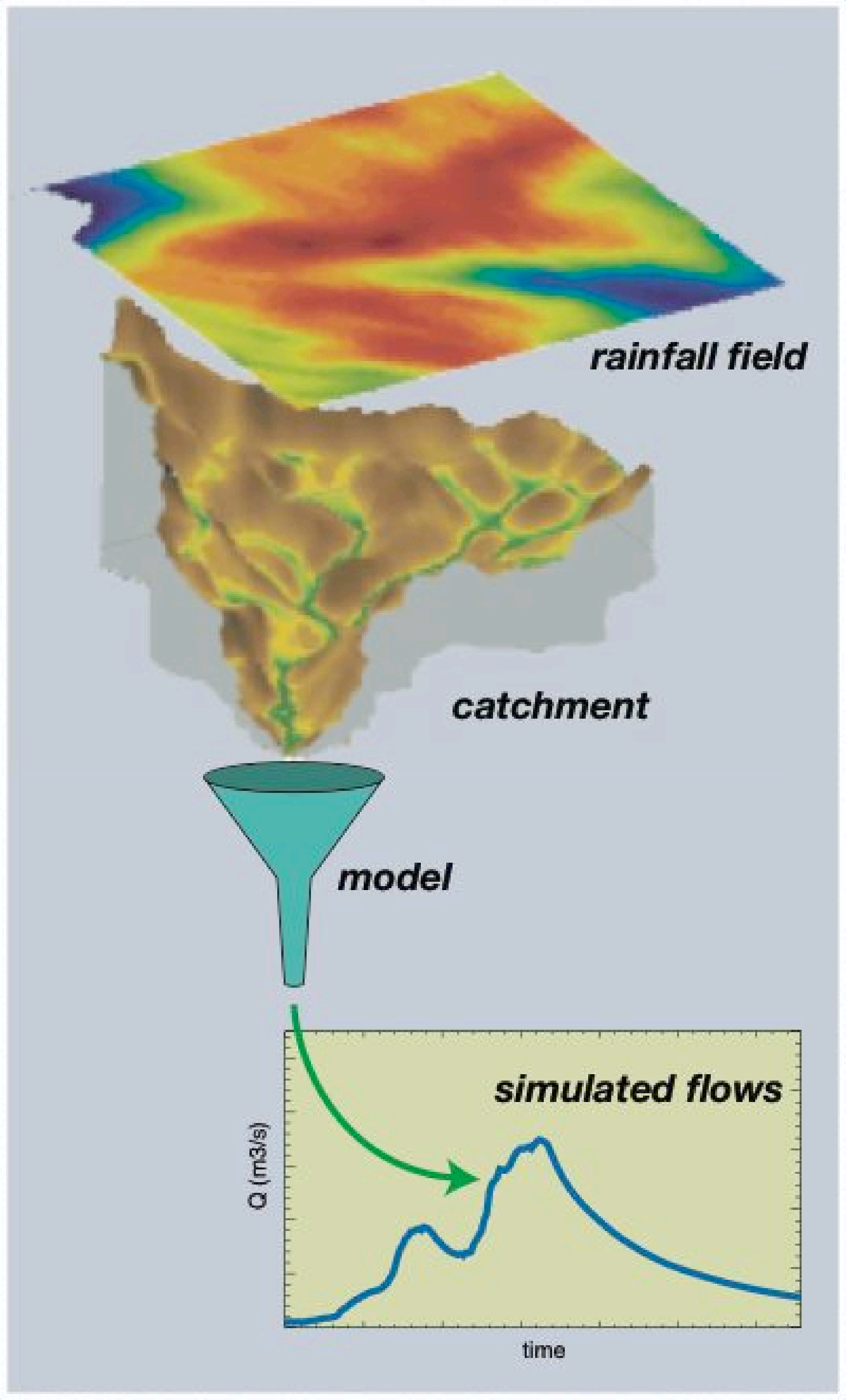


Increasing anticipation of heavy rainfalls



- **High resolution radar nowcasting probabilistic outputs** (ensembles) for FF & DF forecasting (**up to 2 h**)
- **Combining (blending) radar rainfall nowcasting with probabilistic NWP products** (**between 2h and 6h**)
- **Adapting high-resolution meteorological model forecasts** to FF & DF early warnings (**from 6h to 72 h**)

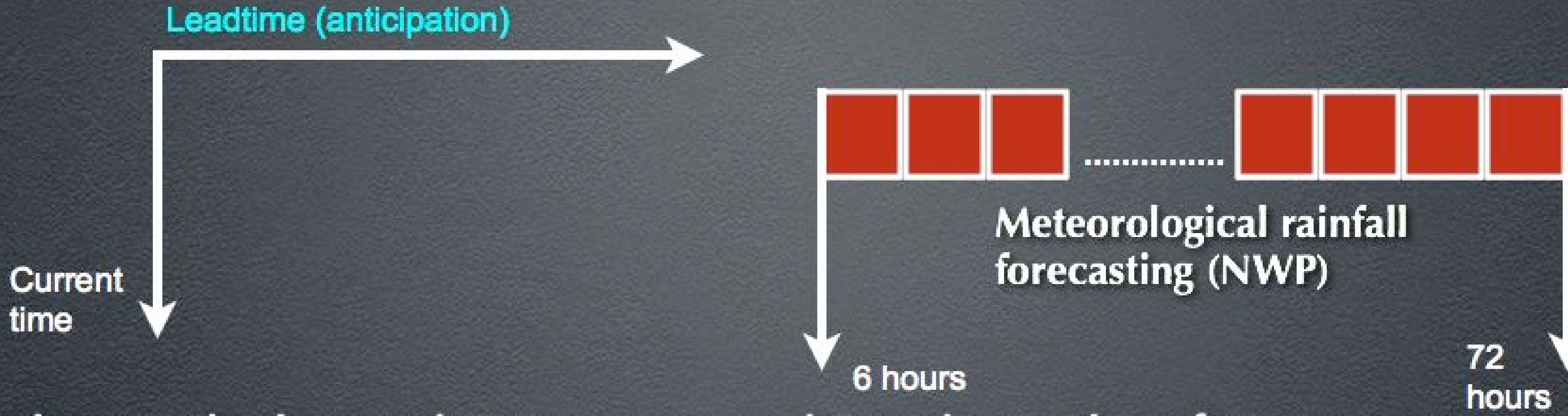
Coupled hydrometeorological forecasting



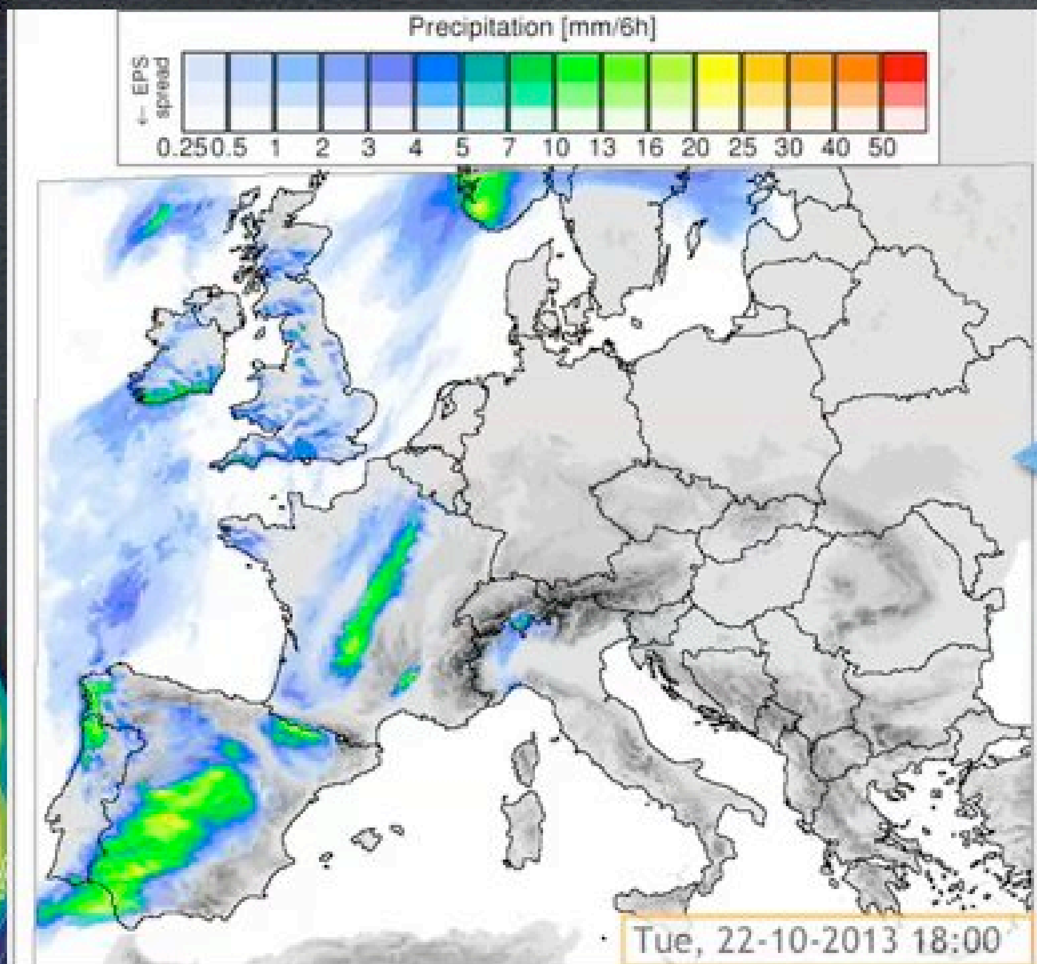
Experience from three European projects coordinated by CRAHI

From 6h to few days in advance

EUROPEAN FLOOD AWARENESS SYSTEM (EFAS)



- Adapting high-resolution meteorological weather forecasts to their use for FF & DF early warnings (from 6h to 72 h)



Initialisation with ECMWF-VAREPS
(15 days, 51 members, 32 km resolution)

Operational COSMO-LEPS 7
7 km spatial resolution
since Dec 2009

Probabilistic Forecast COSMO-LEPS
16 Ensembles

Source: MeteoSwiss-COSMO Consortium

EUROPEAN FLOOD AWARENESS SYSTEM (EFAS)

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European Commission

JOINT RESEARCH CENTRE

copernicus

EFAS

EFAS European Flood Awareness System

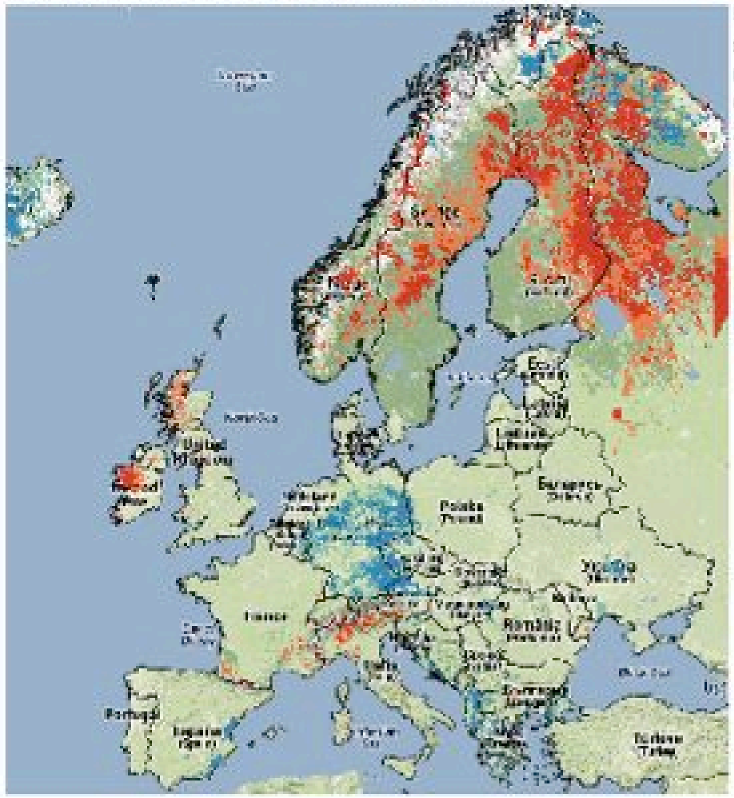
European Commission › JRC › IES › FLOODS action › EFAS-IS

RESOURCES: Floods portal | EU Floods directive | WISE | GDACS |

European Flood Awareness System (EFAS)

The European Commission's "Towards a Stronger European Union Disaster Response" adopted and endorsed by the Council in 2010, underpins the importance of strengthening concerted actions for natural disasters including floods, which are amongst the costliest natural disasters in the EU. The European Flood Awareness System (EFAS), developed to produce European overviews on ongoing and forecasted floods, contributes to better protection of the European Citizen, the environment, property and cultural heritage in support to the EU Mechanism for Civil Protection.
EFAS was developed at the Joint Research Centre of the European Commission in close collaboration with the National hydrological and meteorological services, European Civil Protection through the Emergency Response Coordination Centre (ERCC) and research institutes.
Since 2012 EFAS is an operational service under the umbrella of the Copernicus emergency management service and run by Member States organisations. EFAS also represents the 1st operational hydrological network in Europe.

Soil Moisture Anomaly Map of 22nd of Mar 2014



Deviation of the LISFLOOD simulated daily soil moisture from normal conditions. The normal conditions have been derived using the simulated soil moisture from a 22 year model climatology (1991 - 2012).

Aims of EFAS operational

- added value early flood forecasting products to hydrological services
- unique overview products of ongoing and forecast floods in Europe more than 3 days in advance

MoU Partners Login

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•••••••••••

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EFAS *Bulletins*

2014-02-17
The COPERNICUS Emergency Management Service – Rush Mode Mapping has been triggered for floods by

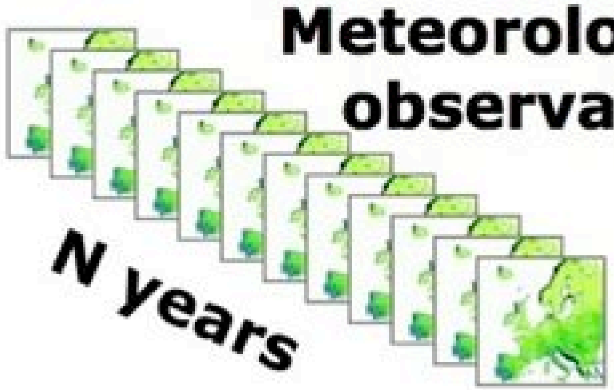
- Slovenia (Ministry of Defence - Administration for Civil Protection and Disaster Relief) on 2014-02-11 14:16 UTC
- UK's Cabinet Office (Civil Contingencies Secretariat) on 10.2.2014 at 10:10 UTC
- France (Centre Operationnel de Gestion Interministeriel de Crises (C.O.G.I.C)) on 2014-02-07 at 11:40
- Portugal (National Command

All details about the activation con

http://www.efas.eu/

EUROPEAN FLOOD AWARENESS SYSTEM (EFAS)

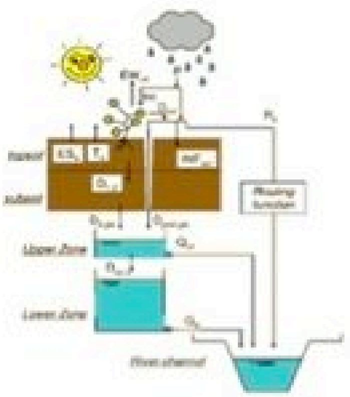
Establish thresholds – from model climatology



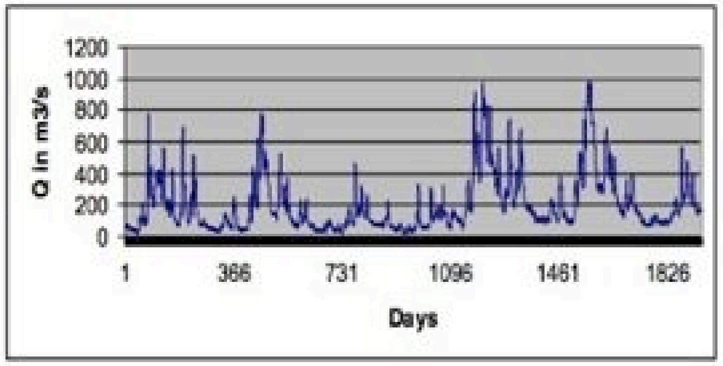
Meteorological observations

N years

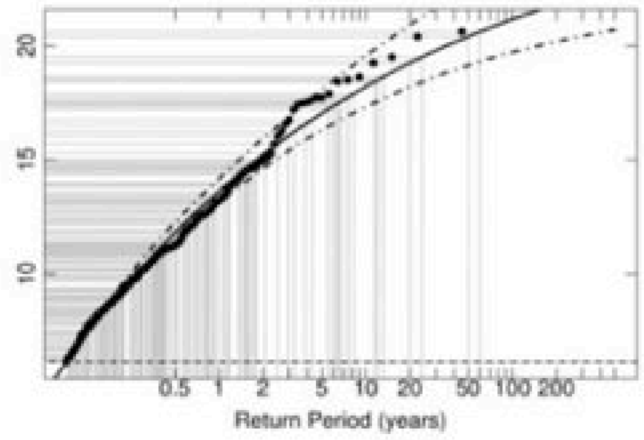
LISFLOOD



Discharge time series



Return period statistics



Thresholds

- **Q20**
- **Q5**
- **Q2**
- **Q1.3**

- **Thresholds are derived from simulated time series.**
- **The same model set-up and parameterisations are used in the forecasts to remain model consistent**

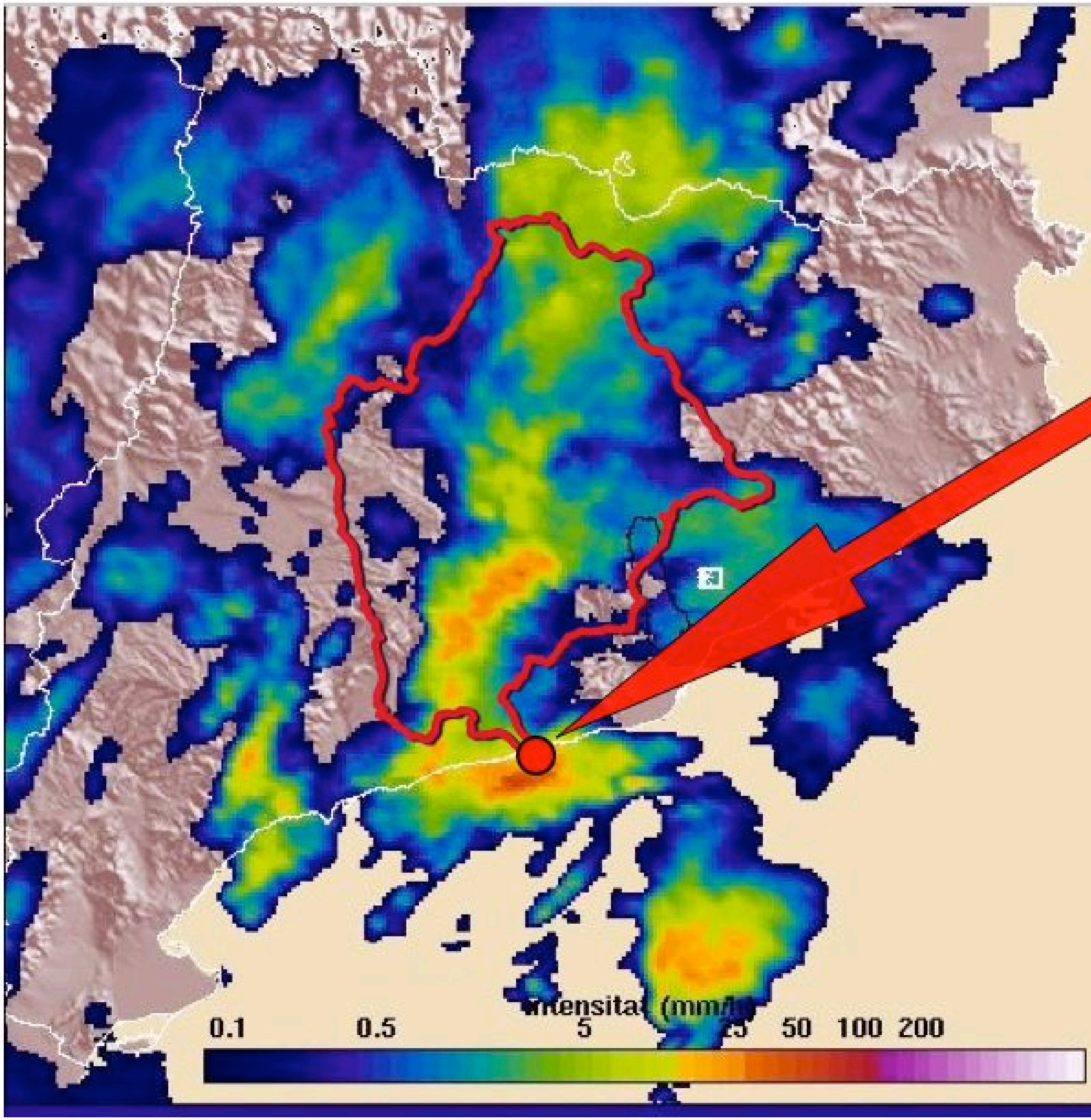
Joint Research Centre

FF & DF early warning systems

In Flash Floods, the basins affected are small (tenths of Km^2) and show very quick responses (from 1/2 hour to few hours)

We need to adapt the system for FF

Basin aggregated rainfall exceedances

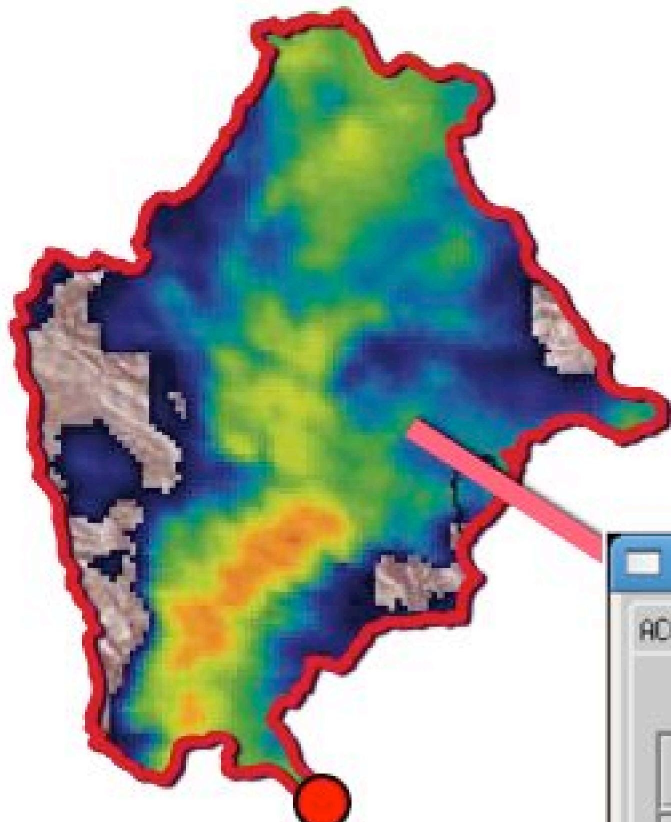


Given a point in the drainage system,

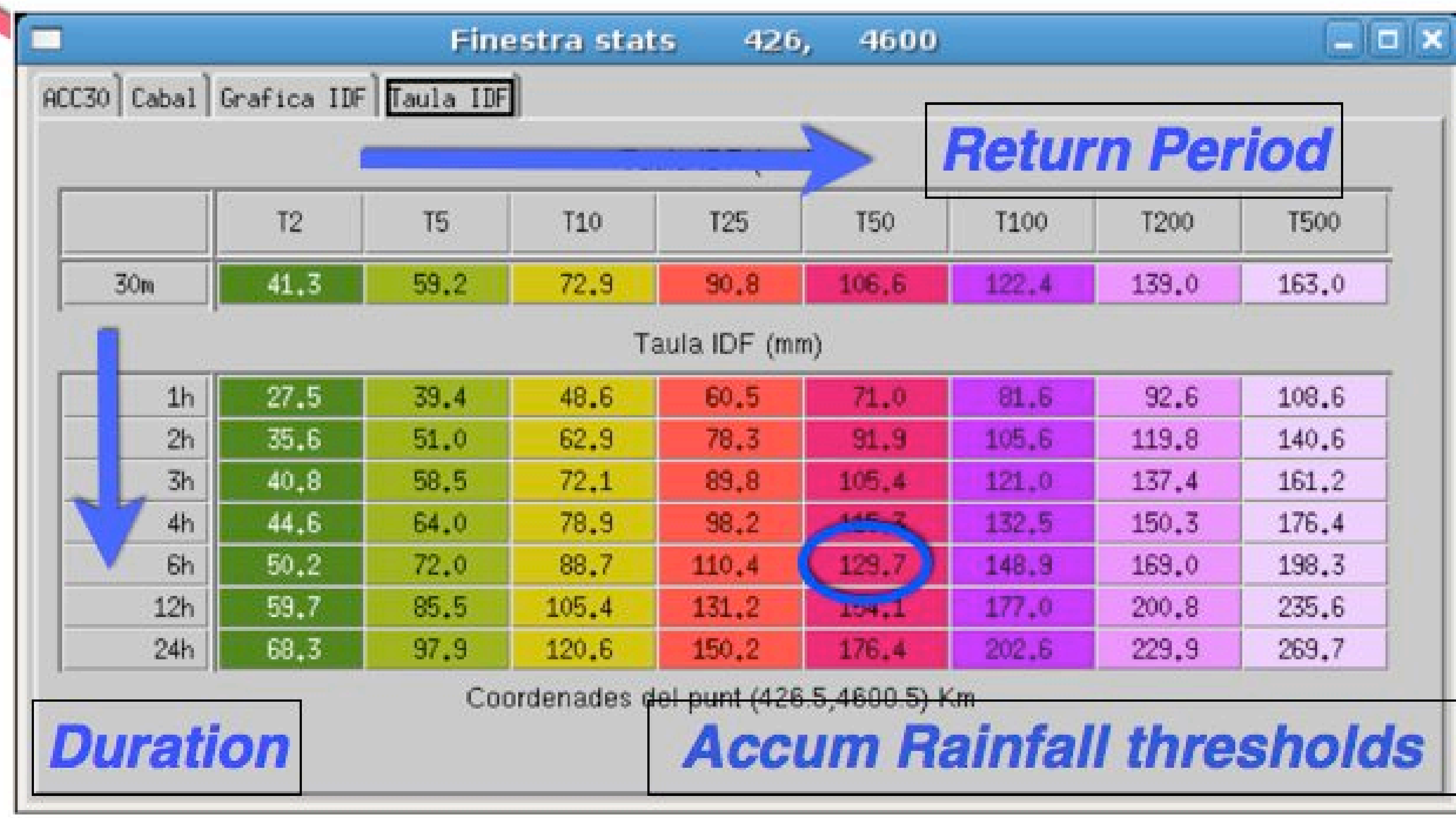
We can define the associated basin, and calculate the rainfall that will be collected by the selected point

Basin aggregated rainfall exceedances

This basin aggregated rainfall is accumulated over the hydrological characteristic time of the basin



And a **probability of Exceedance** is associated (return period in years)



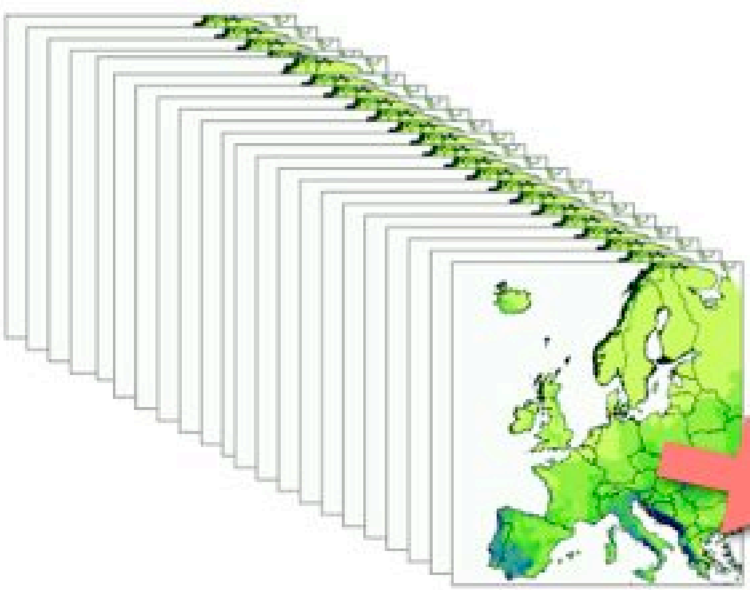
	T2	T5	T10	T25	T50	T100	T200	T500
30m	41.3	59.2	72.9	90.8	106.6	122.4	139.0	163.0
1h	27.5	39.4	48.6	60.5	71.0	81.6	92.6	108.6
2h	35.6	51.0	62.9	78.3	91.9	105.6	119.8	140.6
3h	40.8	58.5	72.1	89.8	105.4	121.0	137.4	161.2
4h	44.6	64.0	78.9	98.2	[illegible]	132.5	150.3	176.4
6h	50.2	72.0	88.7	110.4	129.7	148.9	169.0	198.3
12h	59.7	85.5	105.4	131.2	[illegible]	177.0	200.8	235.6
24h	68.3	97.9	120.6	150.2	176.4	202.6	229.9	269.7

EPIC: European Precipitation Index Climatology

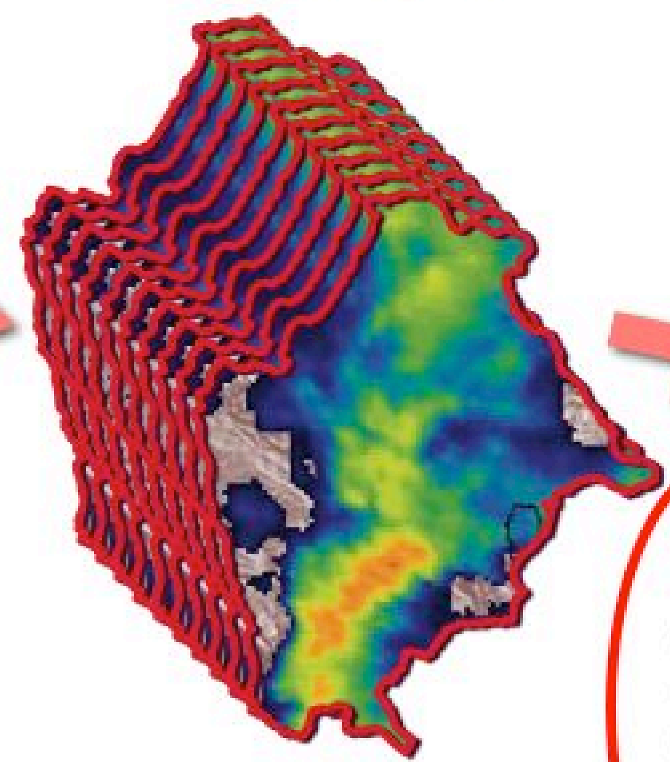
- **30 Years of COSMO-LEPS** reanalysis have been generated.
- For any point in the river system (1 km^2) a **Climatology of its basin aggregated rainfall** is calculated.
- A Precipitation Index based on Climatology is thus calculated at European scale (**EPIC**).
- For any new event the rainfall forecasted is used to calculate the **basin aggregated rainfall, and compared against the EPIC CLIMATOLOGY.**

FF & DF early warning systems

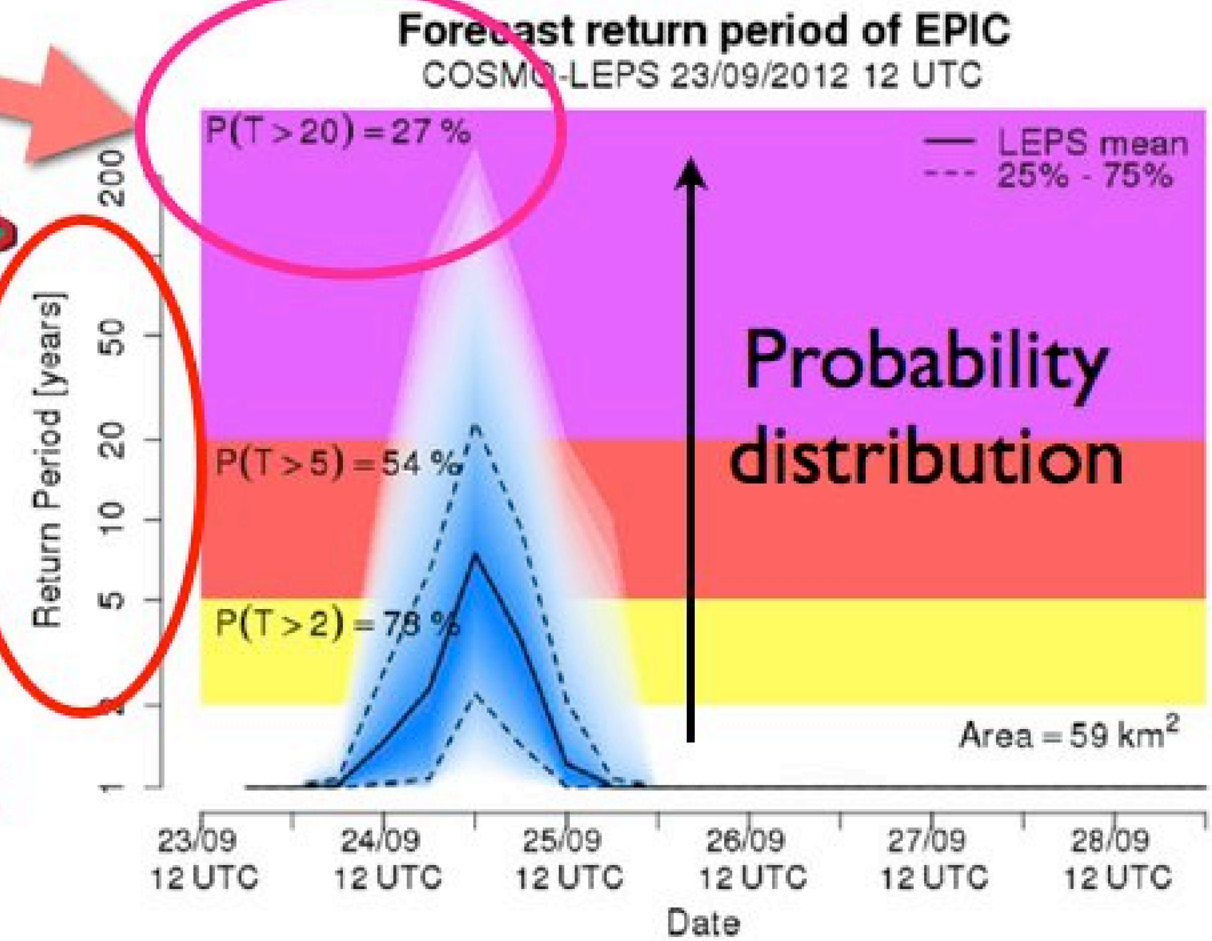
COSMO-LEPS
Probabilistic Rainfall forecasts



Probabilistic basin aggregated rainfall forecasts



Warning code associated to the 75% percentile member



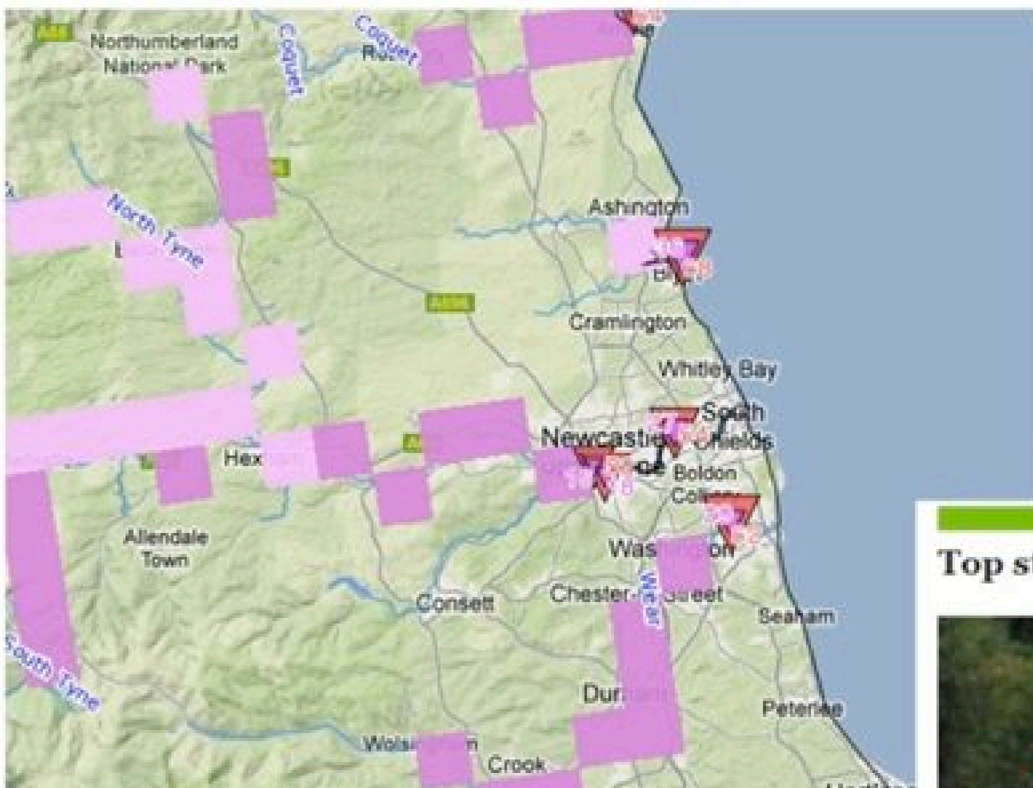
Return Period of any member calculated by comparison against EPIC climatology

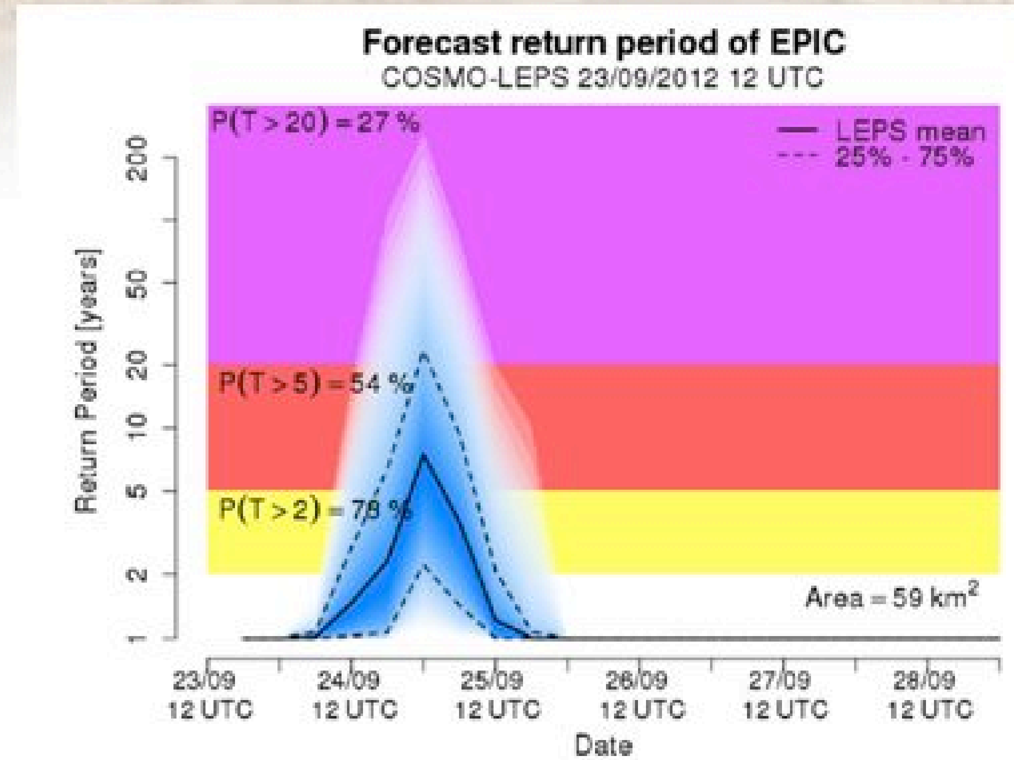
FF & DF early warning systems

IMPRINTS

Event of 2012-09-25 in Newcastle Upon Time (UK)

EPIC 2012-09-23 12:00





Forecast 48h in advance

Top story

Floods hit 300 homes in north England

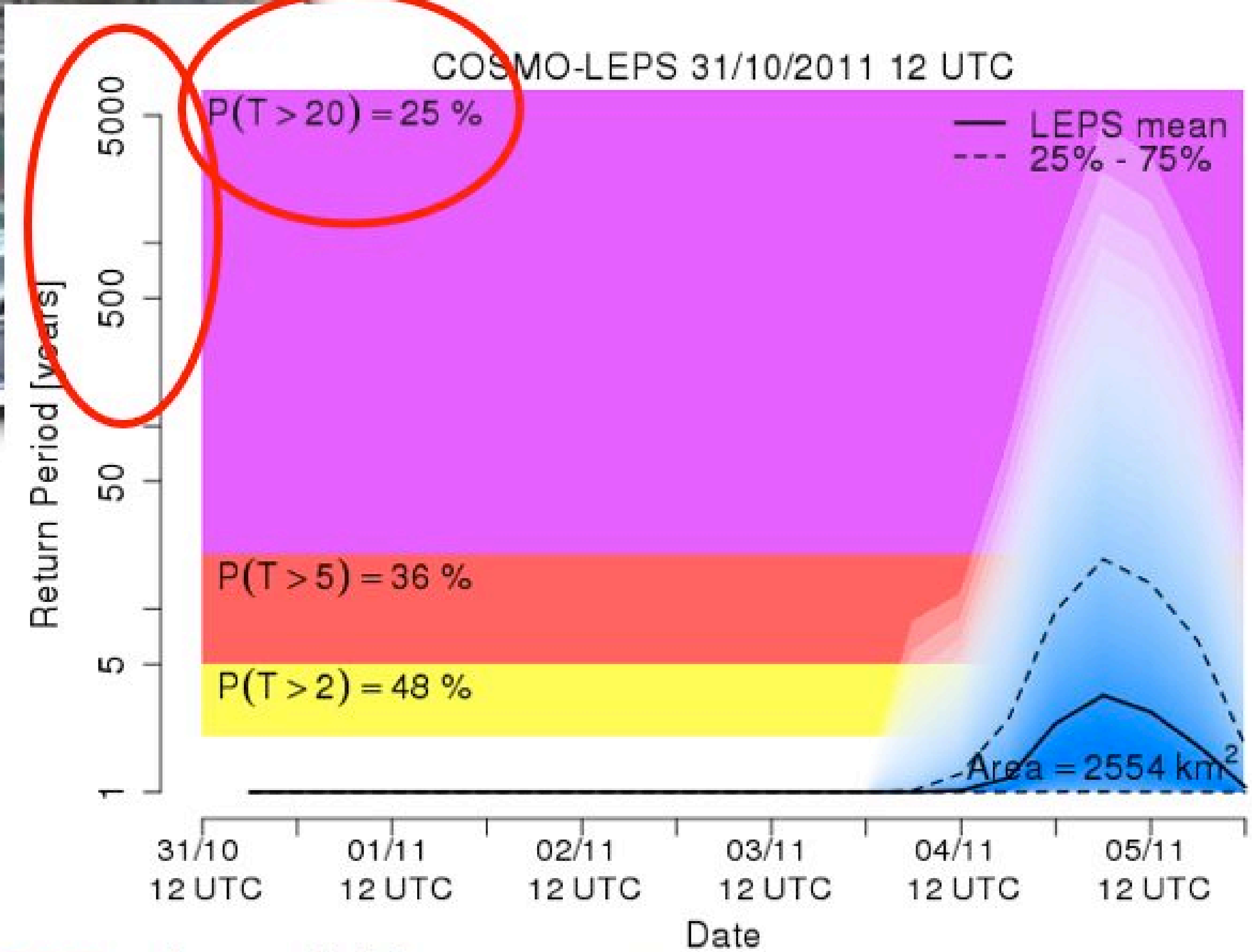
26 Sep 2012: River defences under pressure in downpours, while fishing village is left covered in sea foam

Most recent

Looters of flooded shop condemned by police

26 Sep 2012: Newcastle upon Tyne cycle shop targeted as swollen rivers cause havoc in northern England

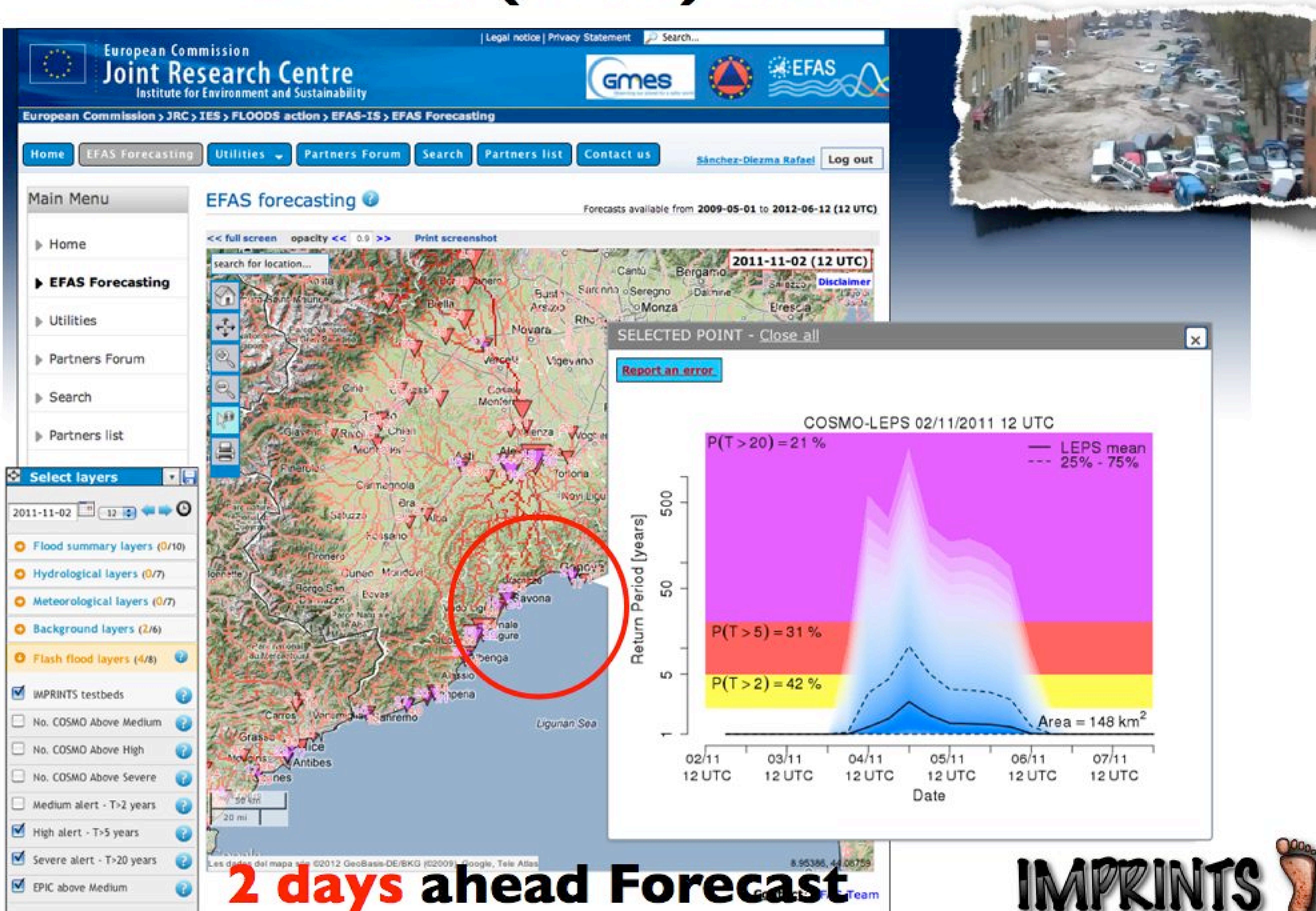
Genova (Italia) 4/11/2011



4 days ahead Forecast

IMPRINTS

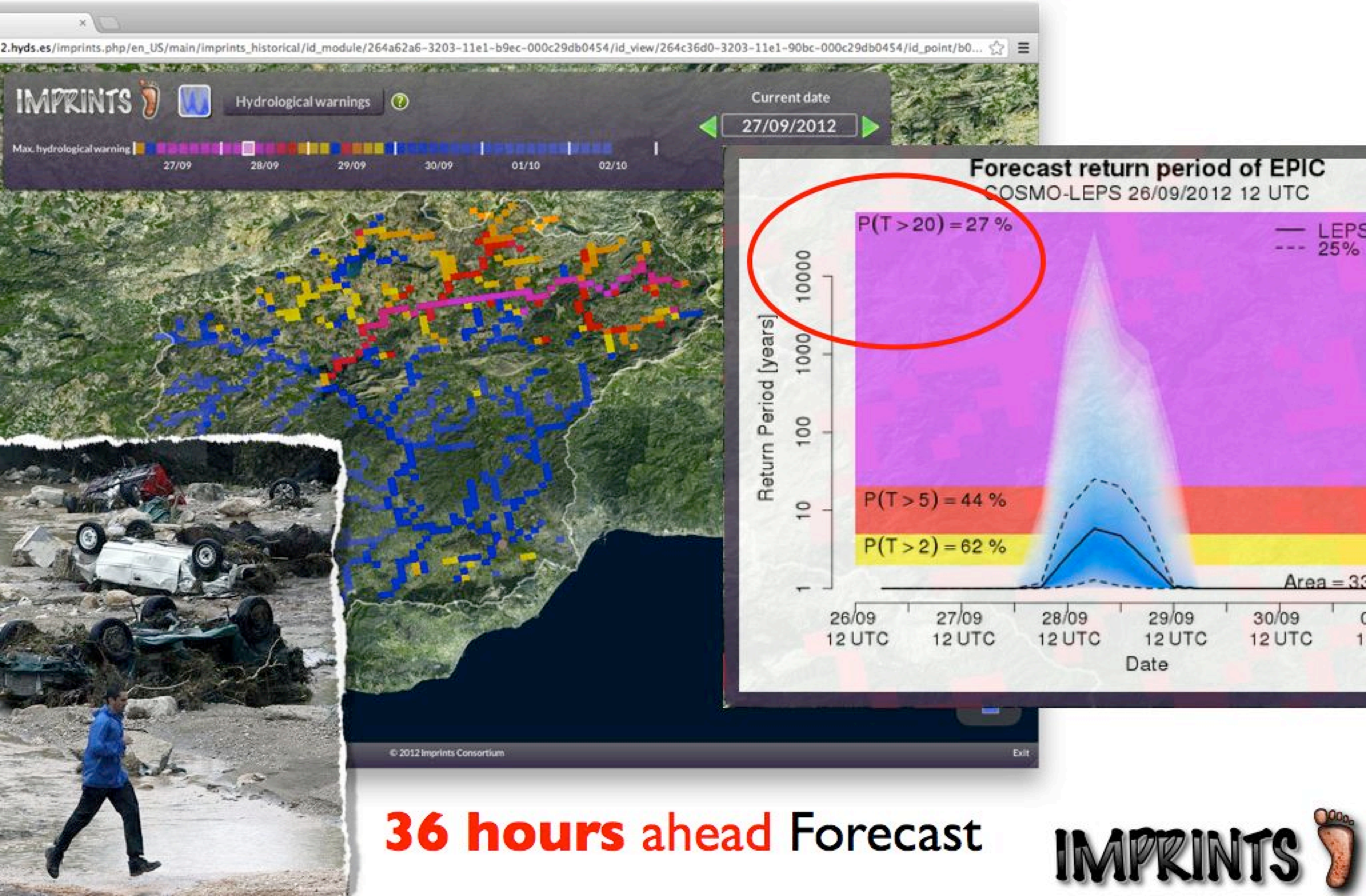
Genova (Italia) 4/11/2011



2 days ahead Forecast

IMPRINTS

Guadalhorce 28/09/2012



36 hours ahead Forecast

IMPRINTS

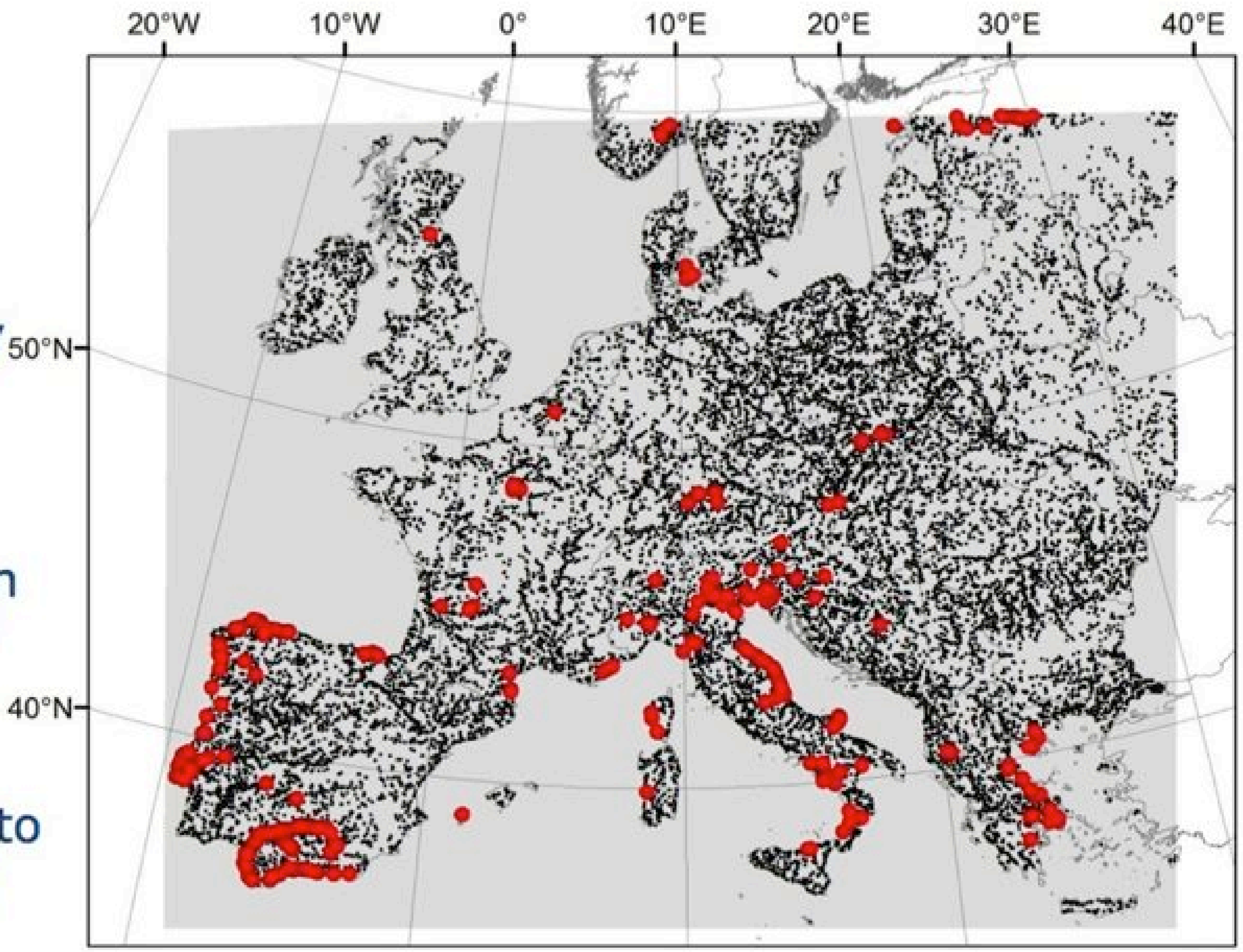
Performance of EPIC

22 months data starting on 1/12/2009.

We derived an alert criterion for extreme events of 60% probability of exceeding the 5-year return period.

363 points above the alert criterion were clustered in 50 events, 42 of which were confirmed events.

Out of 8 false alarms, 3 were due to boundary issues and can be easily recognized and removed



HARREN

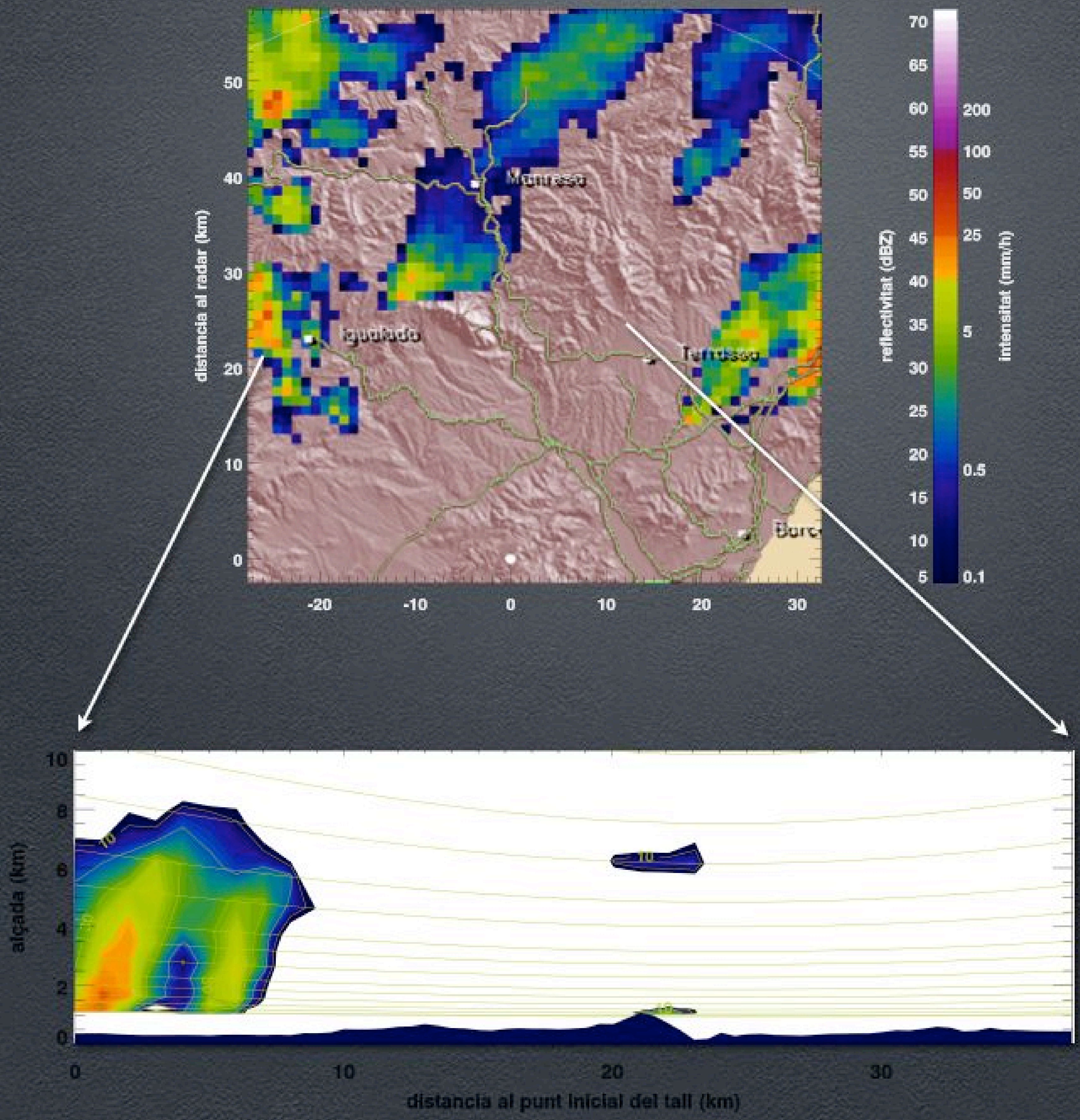
European Civil Protection

Can we increase the resolution in time and space using radar data up to 6h in advance?

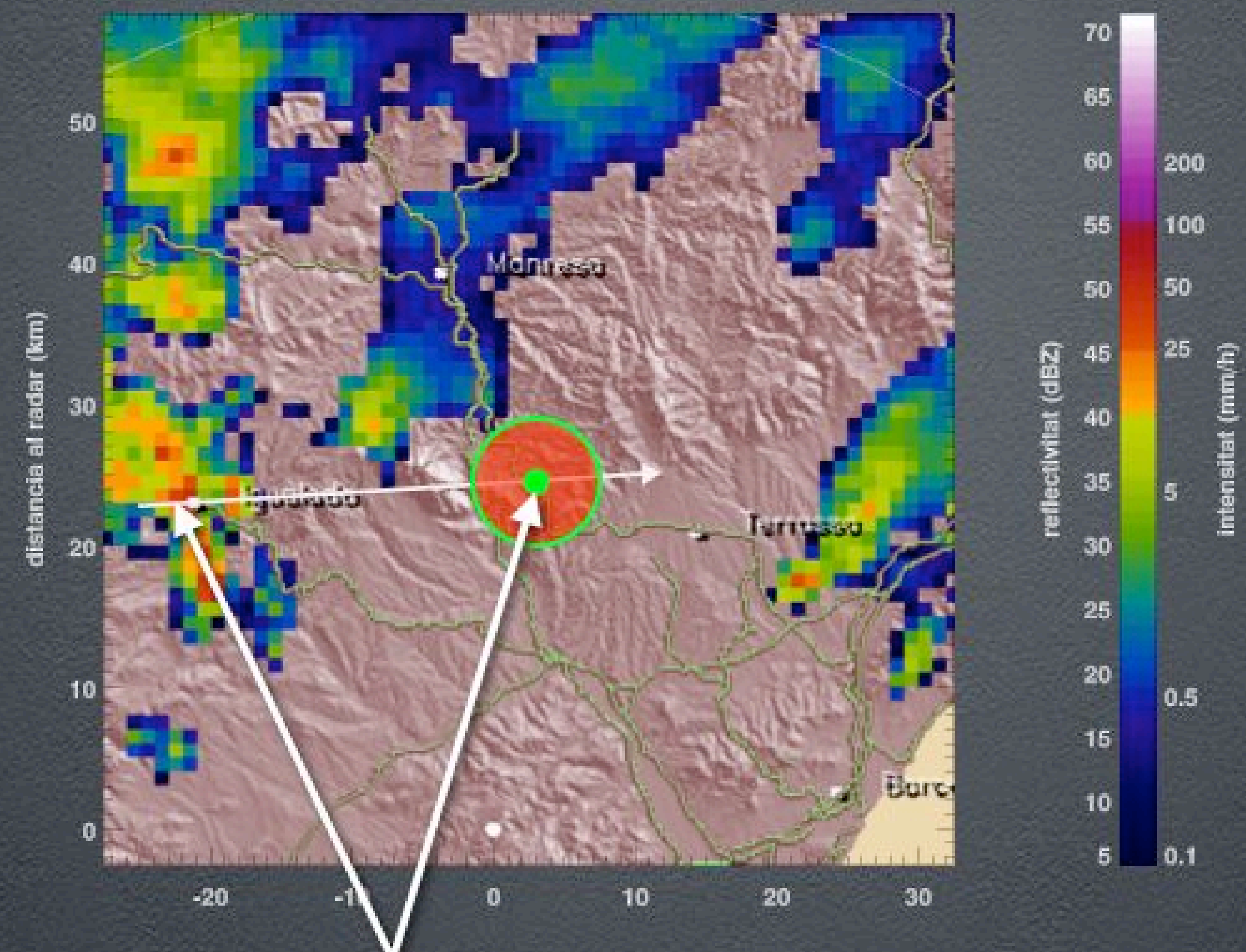
CRAHI UPC

TECNIO Be tech. Be competitive

21:30

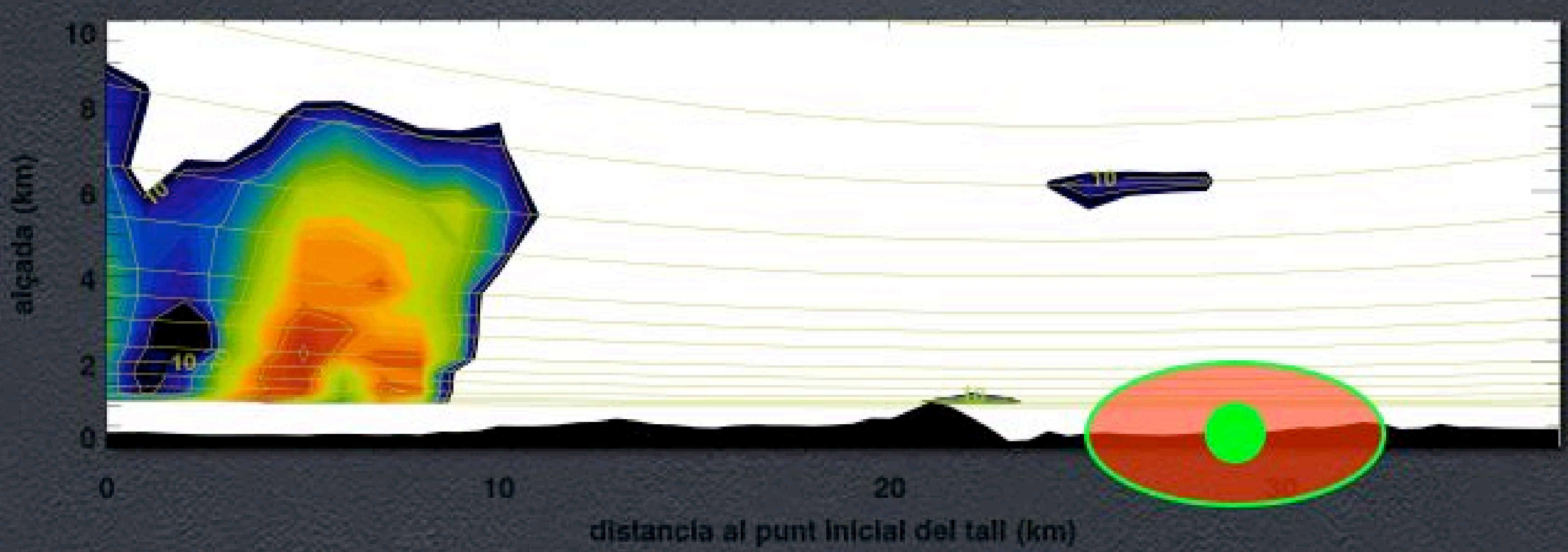

Manresa
Igualada
Terrassa
distancia al radar (km)
reflectivitat (dBZ)
intensitat (mm/h)
alçada (km)
distancia al punt inicial del tall (km)

21:36



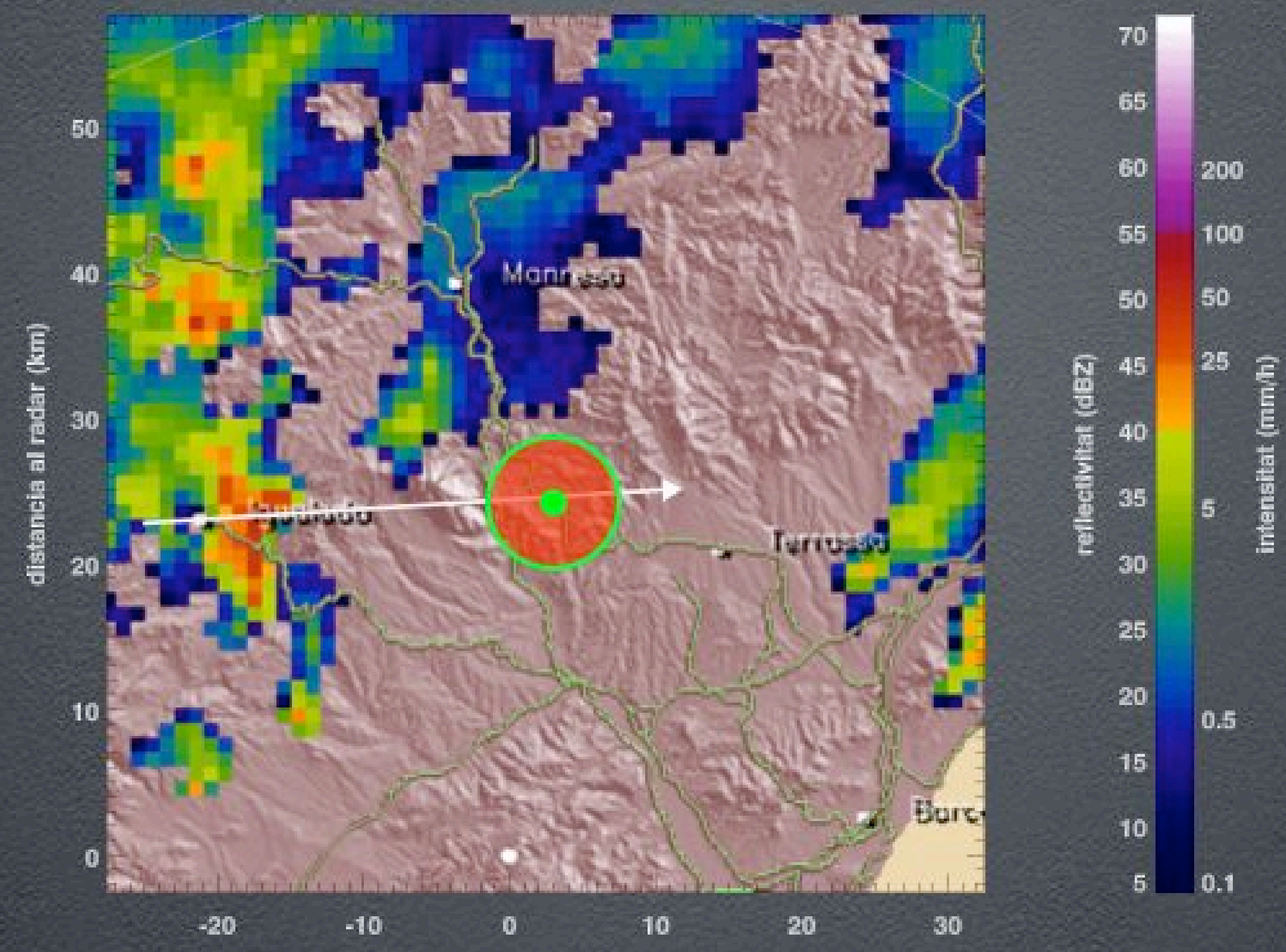
Manresa
Igualada
Terrassa
distancia al radar (km)
reflectivitat (dBZ)
intensitat (mm/h)

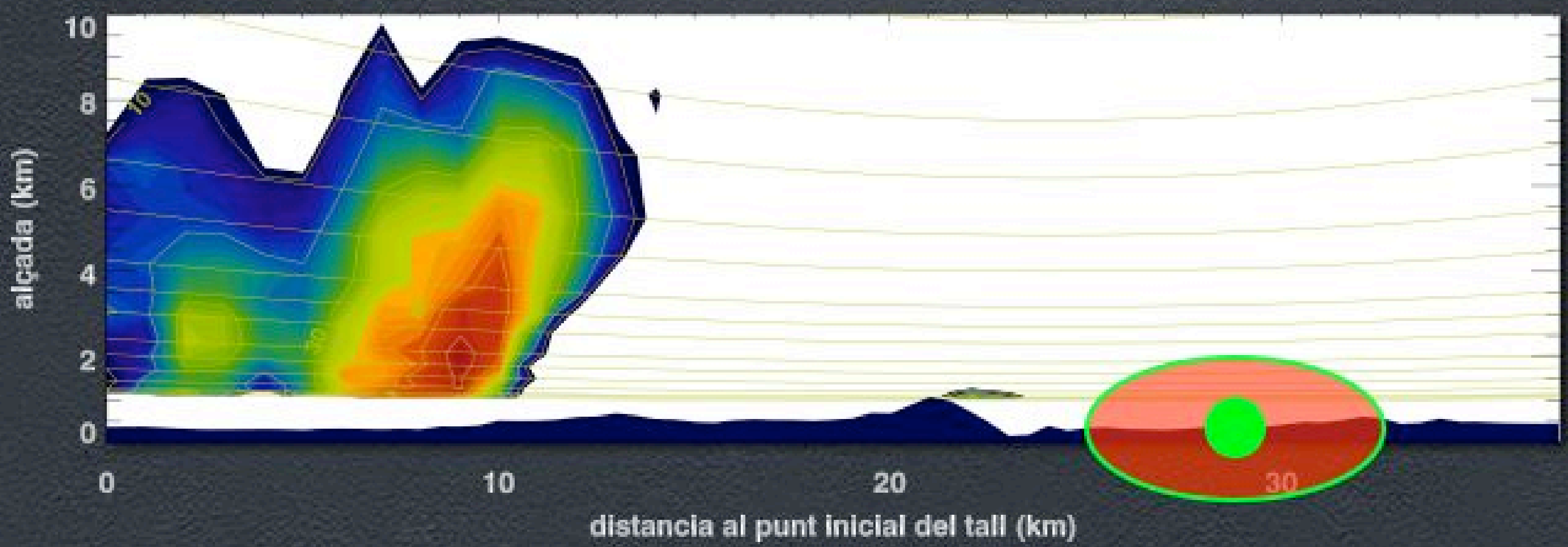
Δt



alçada (km)
distancia al punt inicial del tall (km)

21:42





TECNIO Be tech. Be competitive

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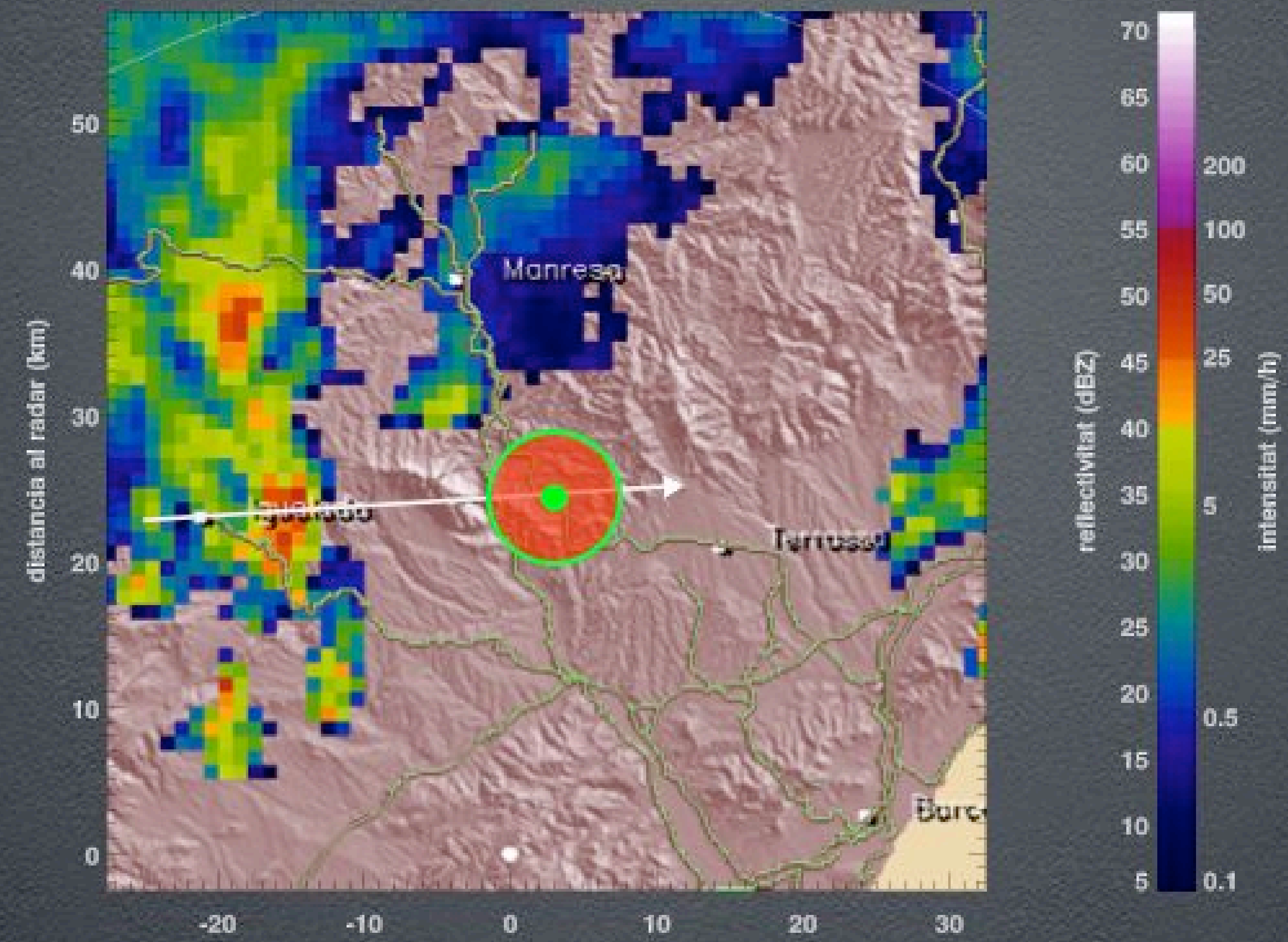
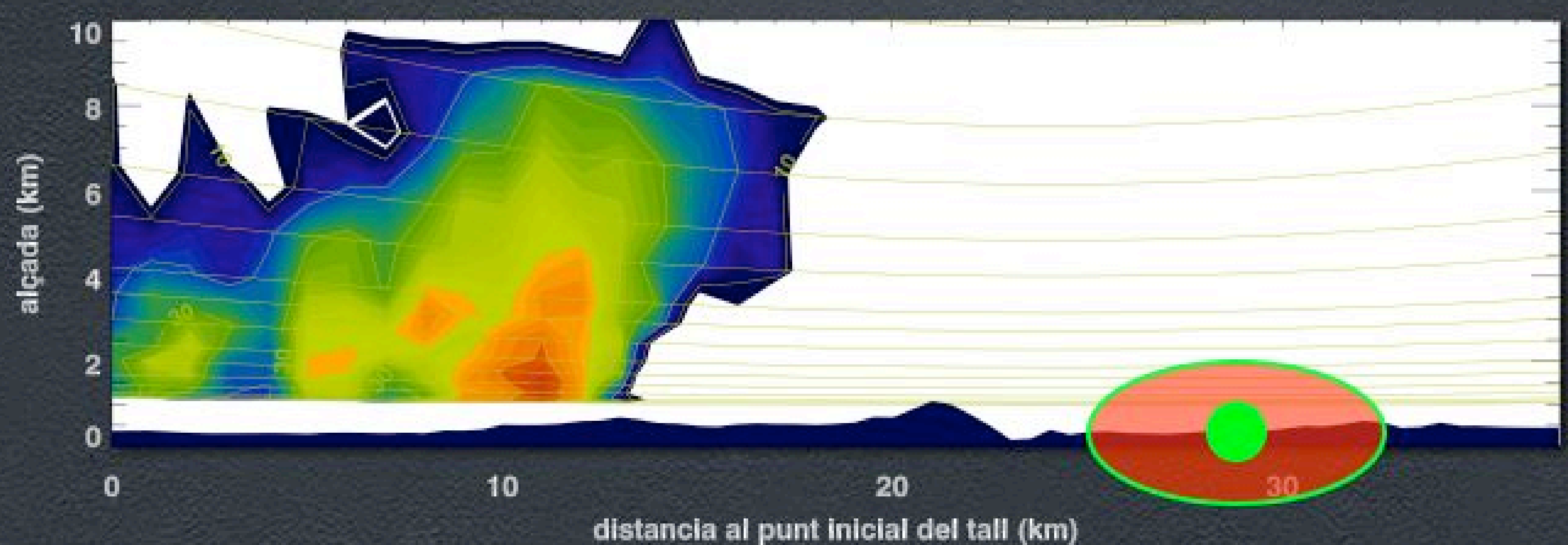
21:48





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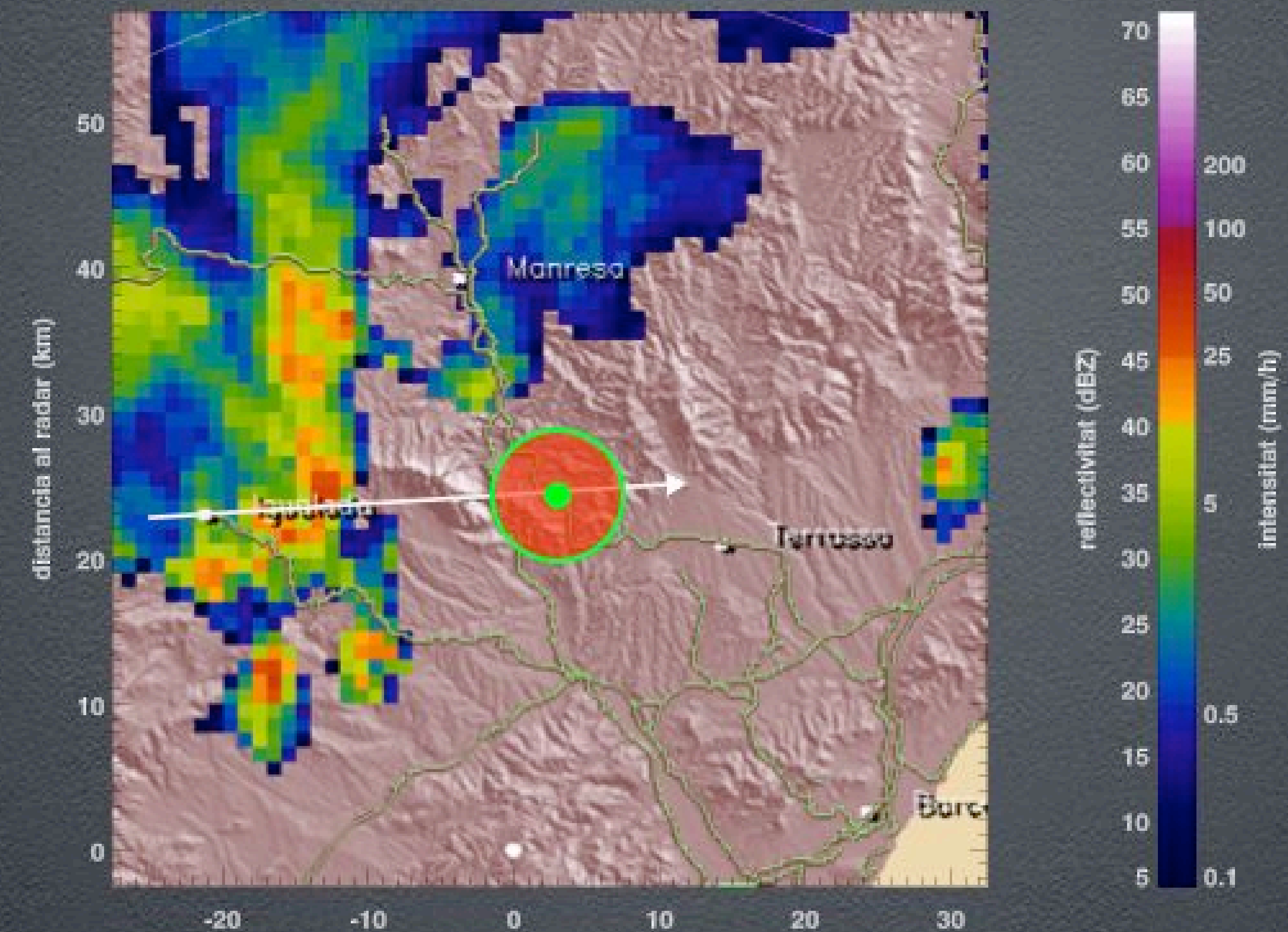
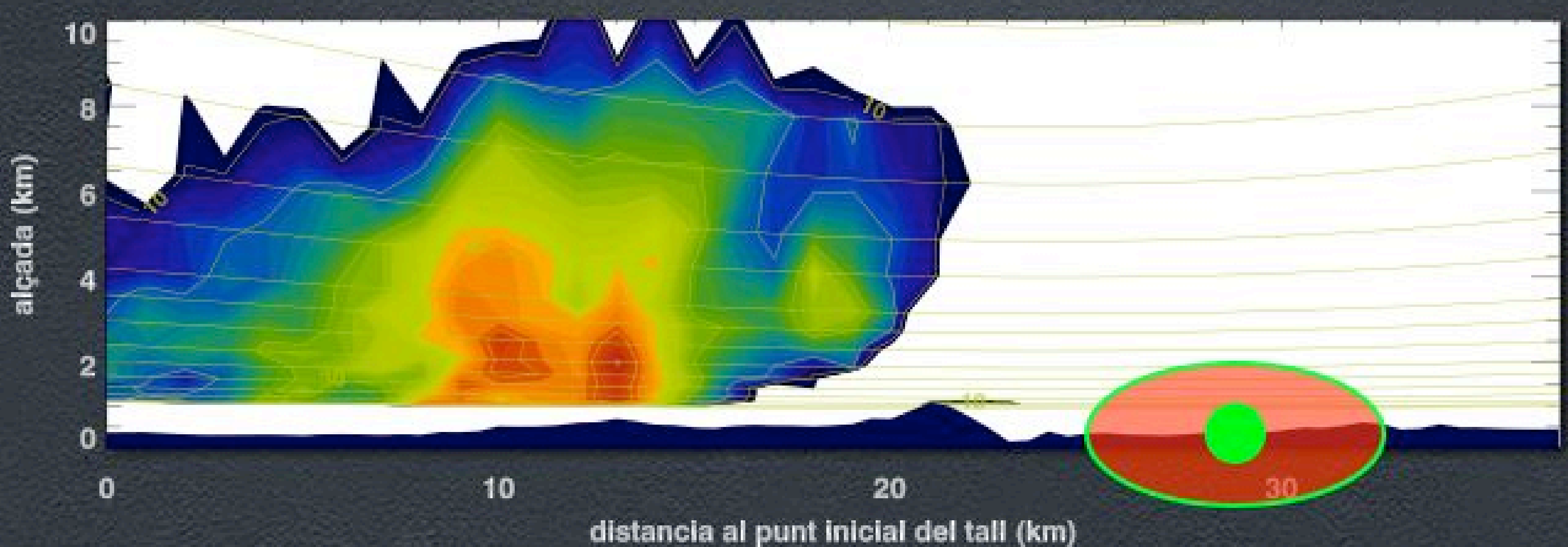
21:54





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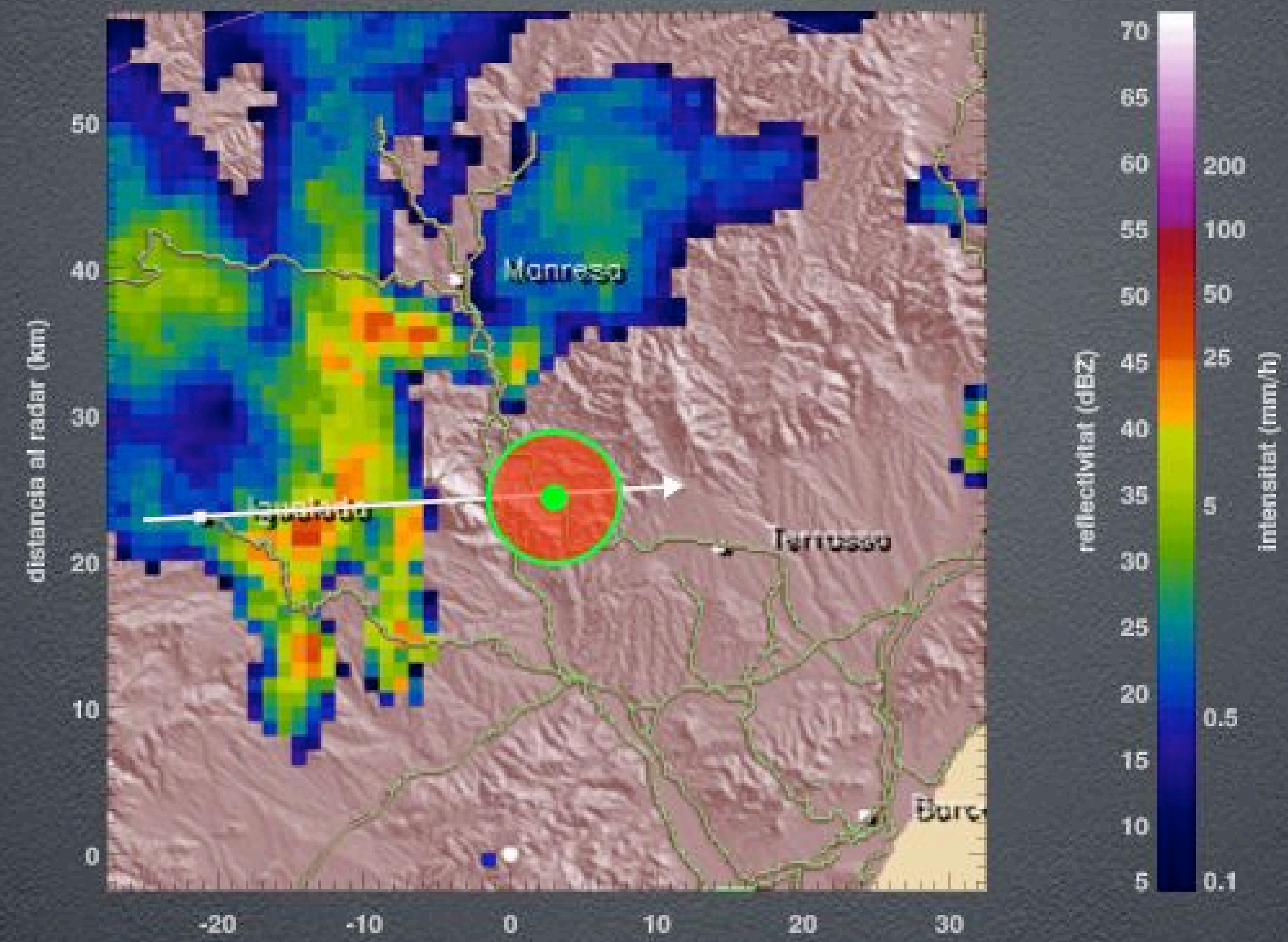
22:00


Manresa
Igualada
Terrassa
distancia al radar (km)
reflectivitat (dBZ)
intensitat (mm/h)
70
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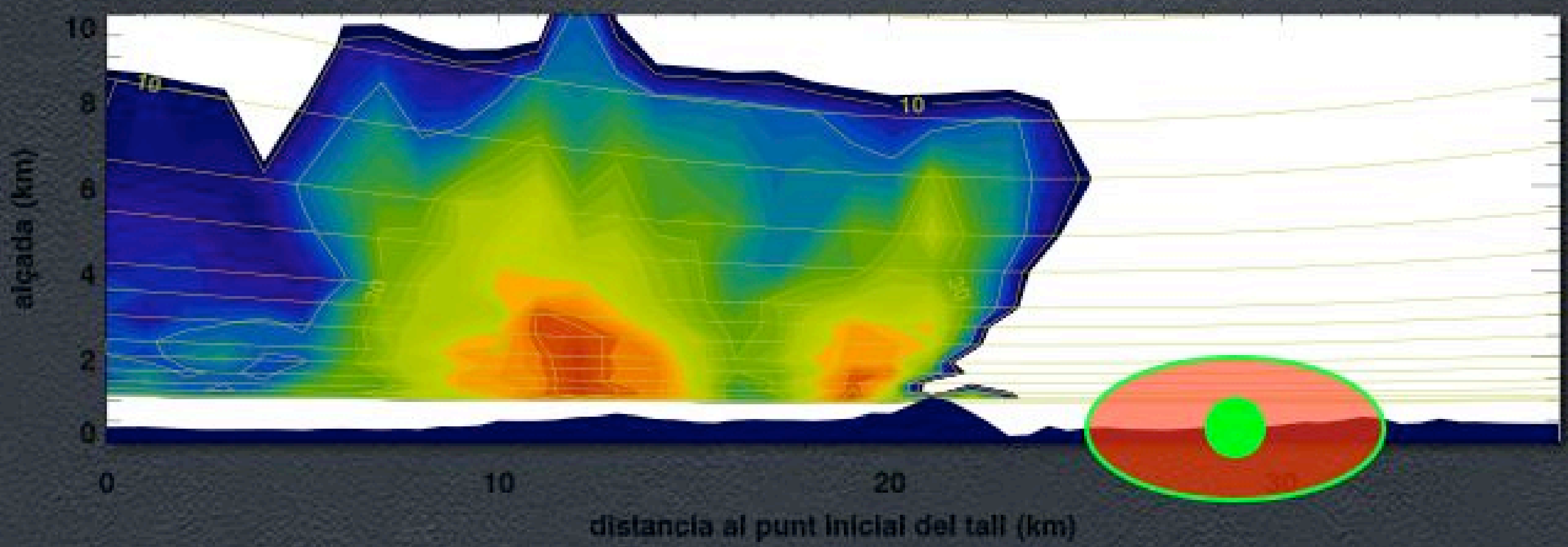
alçada (km)
distancia al punt inicial del tall (km)
0
2
4
6
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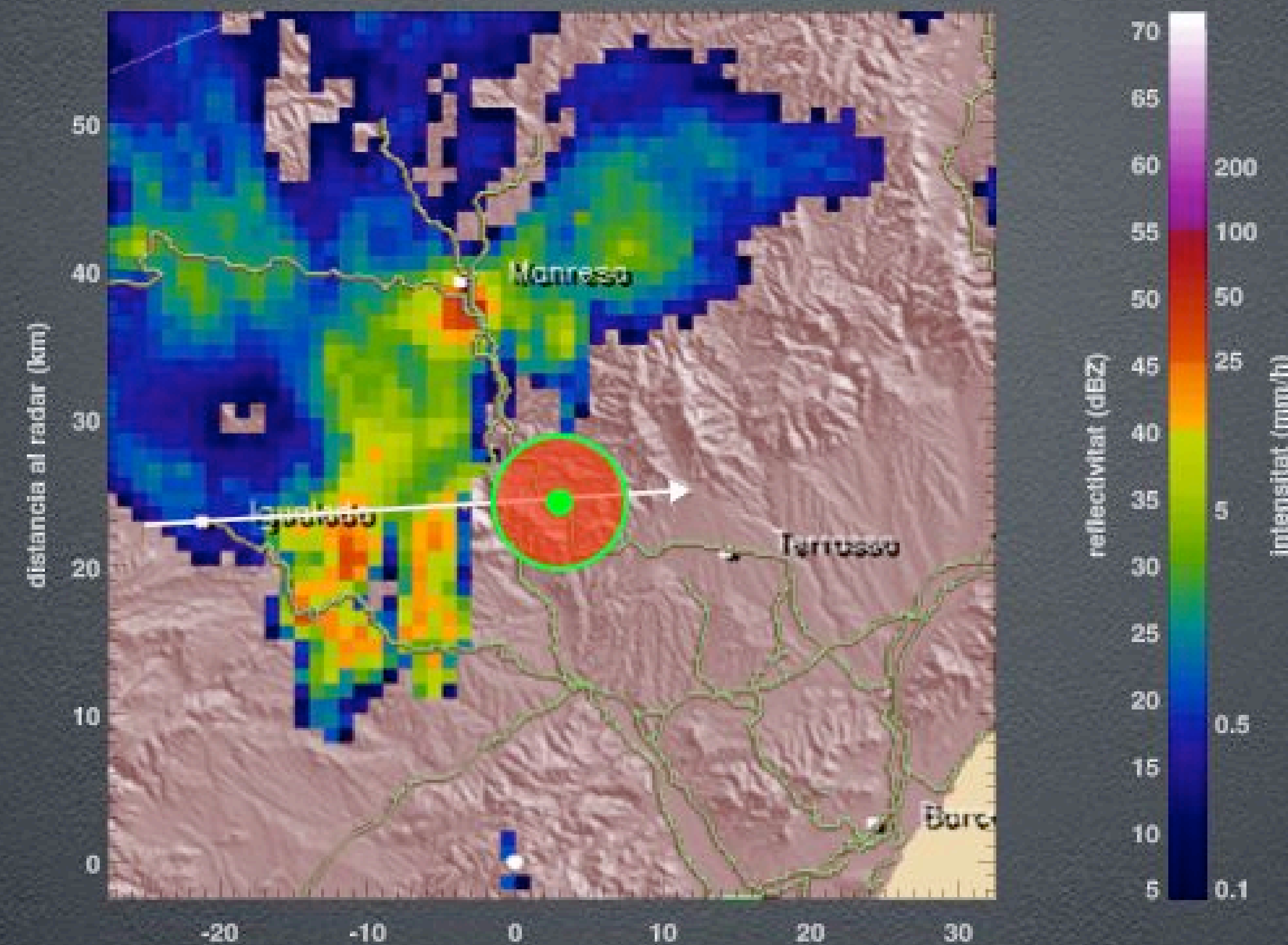
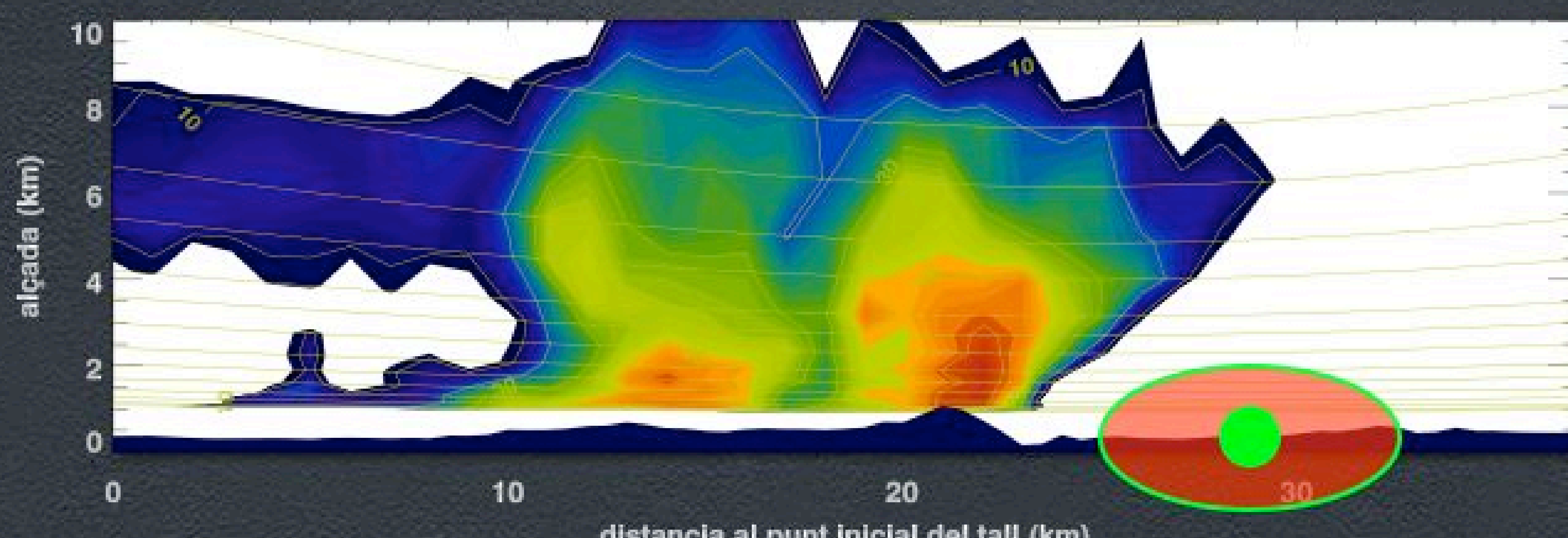
10
20
30

22:06

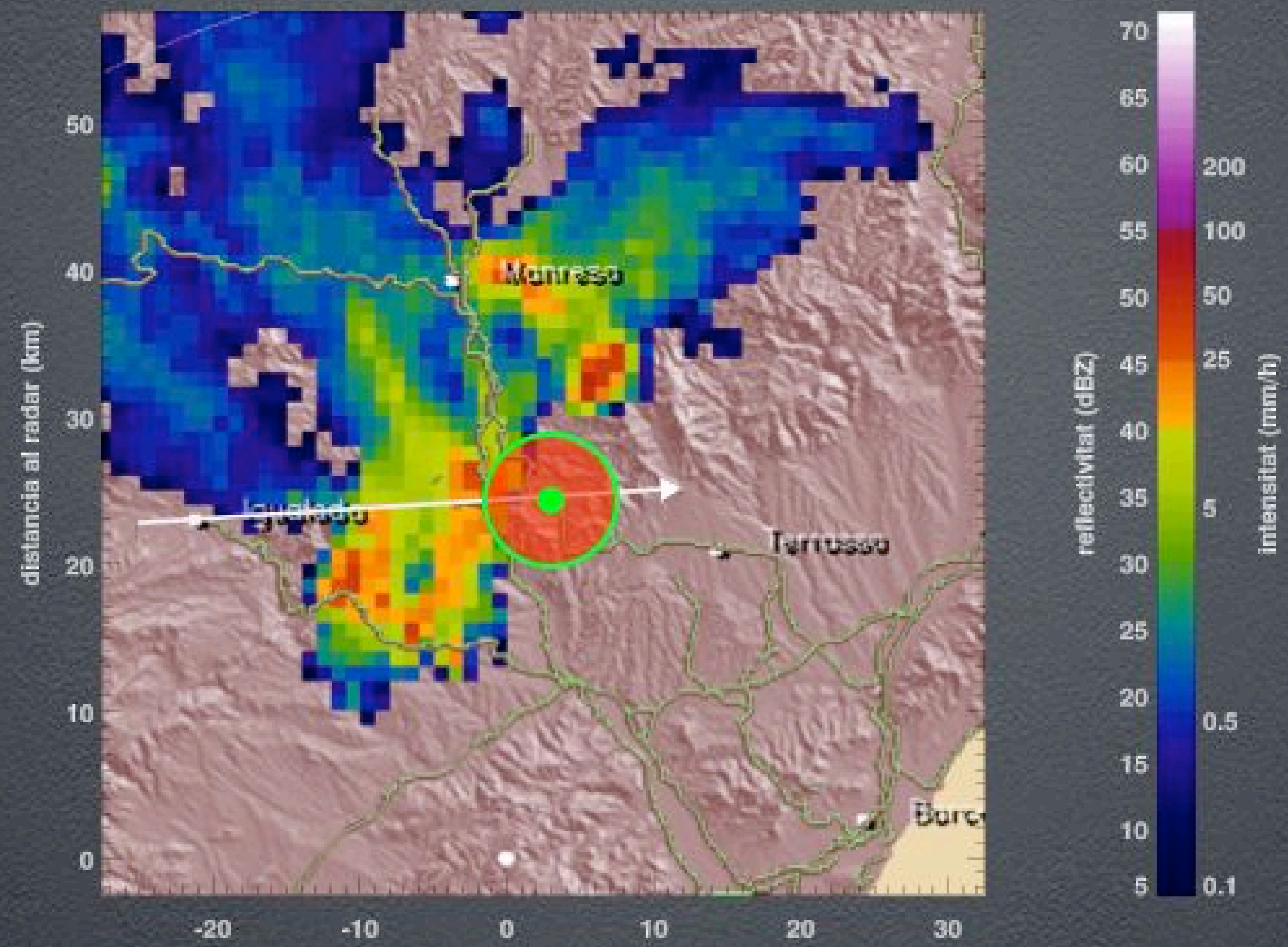


Manresa
Igualada
Terrassa
Barc
distancia al radar (km)
reflectivitat (dBZ)
intensitat (mm/h)



alçada (km)
distancia al punt inicial del tall (km)

22:12


Manresa
Igualada
Terrassa
Barc
distancia al radar (km)
reflectivitat (dBZ)
intensitat (mm/h)
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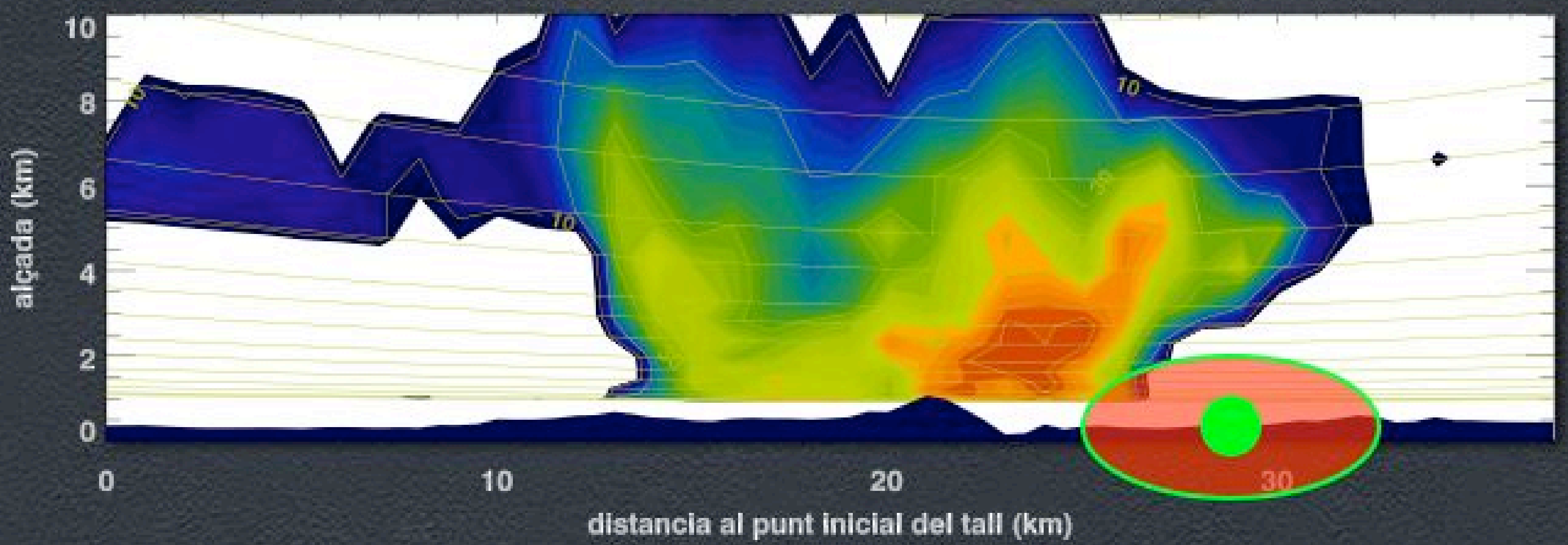
alçada (km)
distancia al punt inicial del tall (km)
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20
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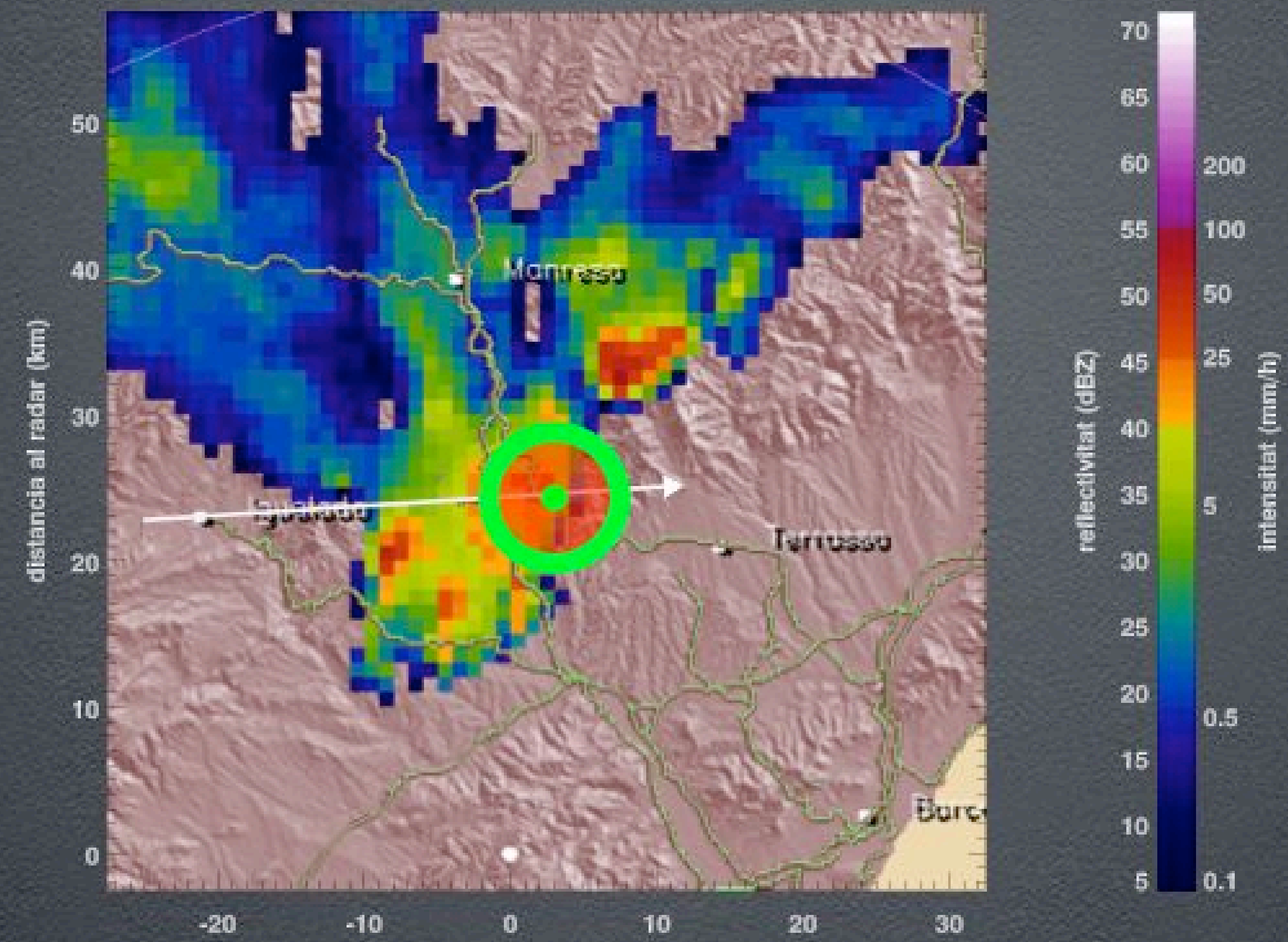
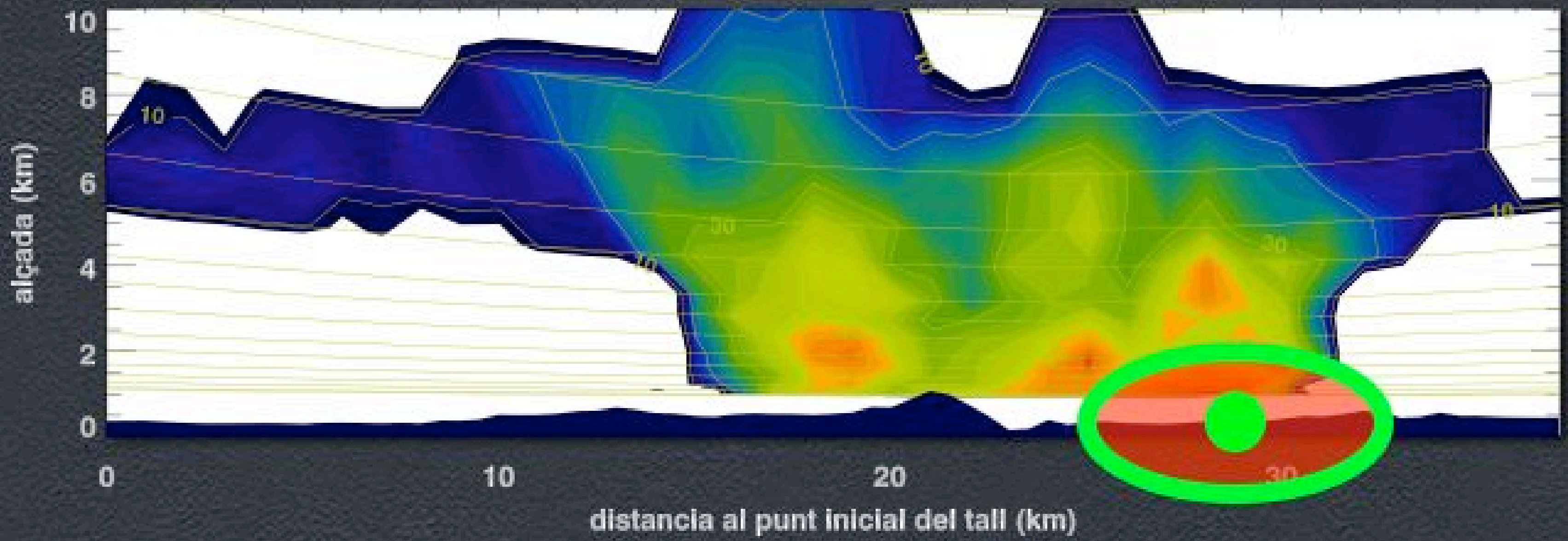
22:18

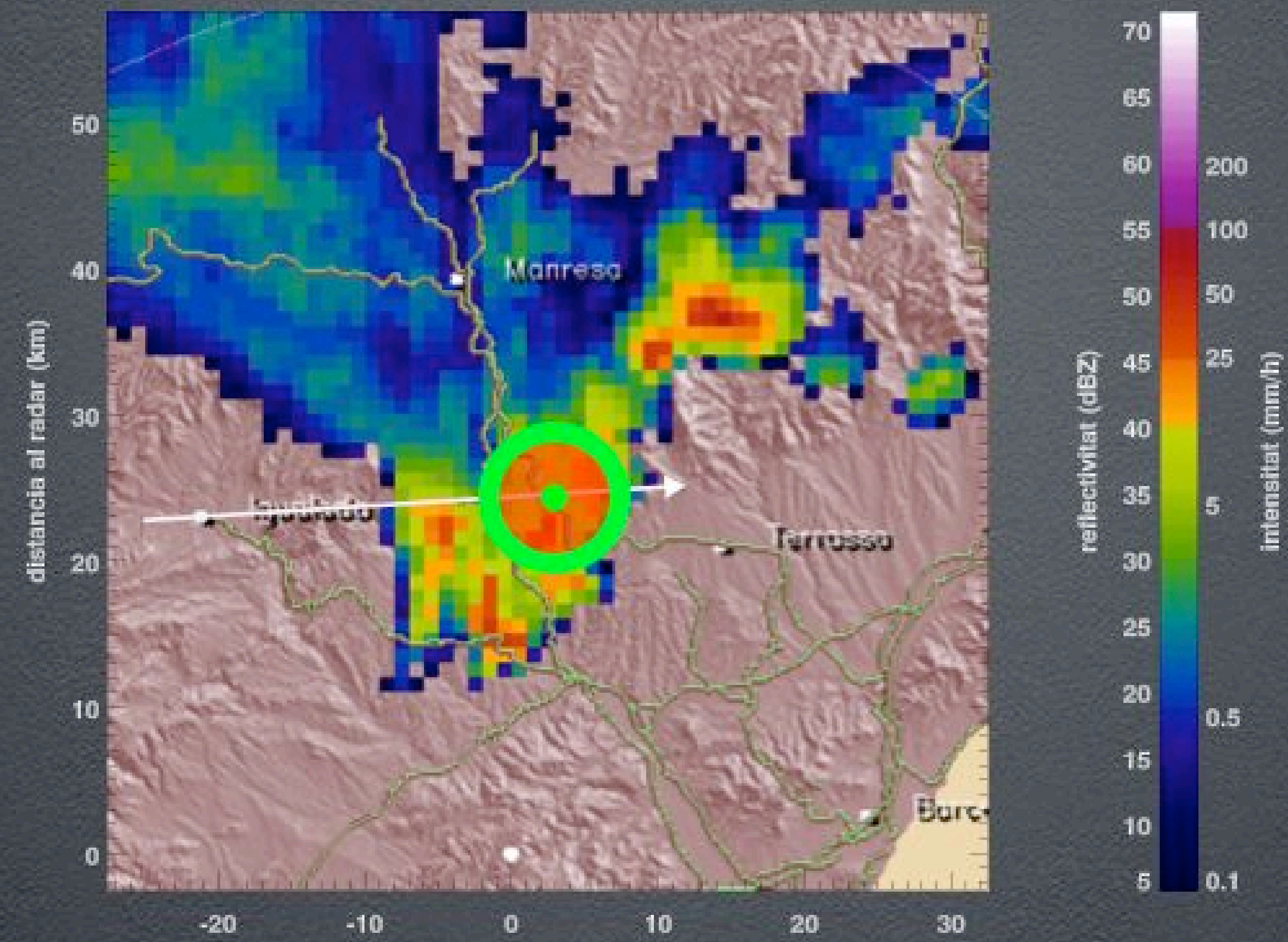


Manresa
Igualada
Terrassa
distancia al radar (km)
reflectivitat (dBZ)
intensitat (mm/h)



alçada (km)
distancia al punt inicial del tall (km)

22:24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Igualada
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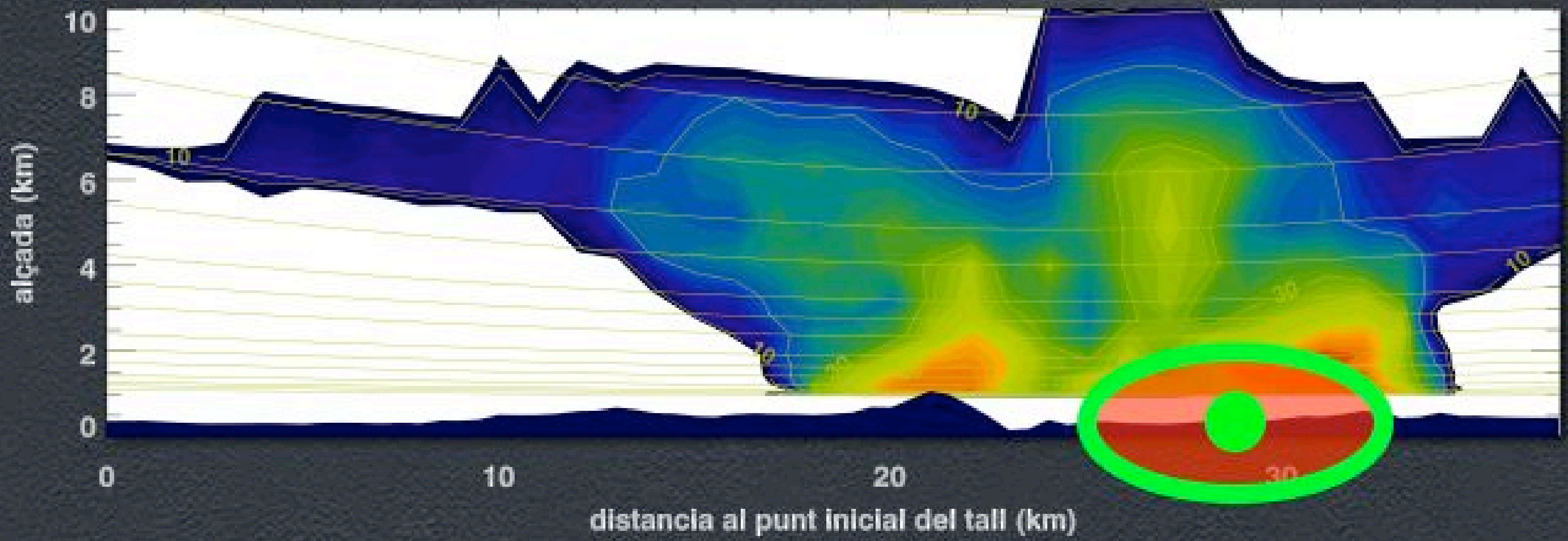
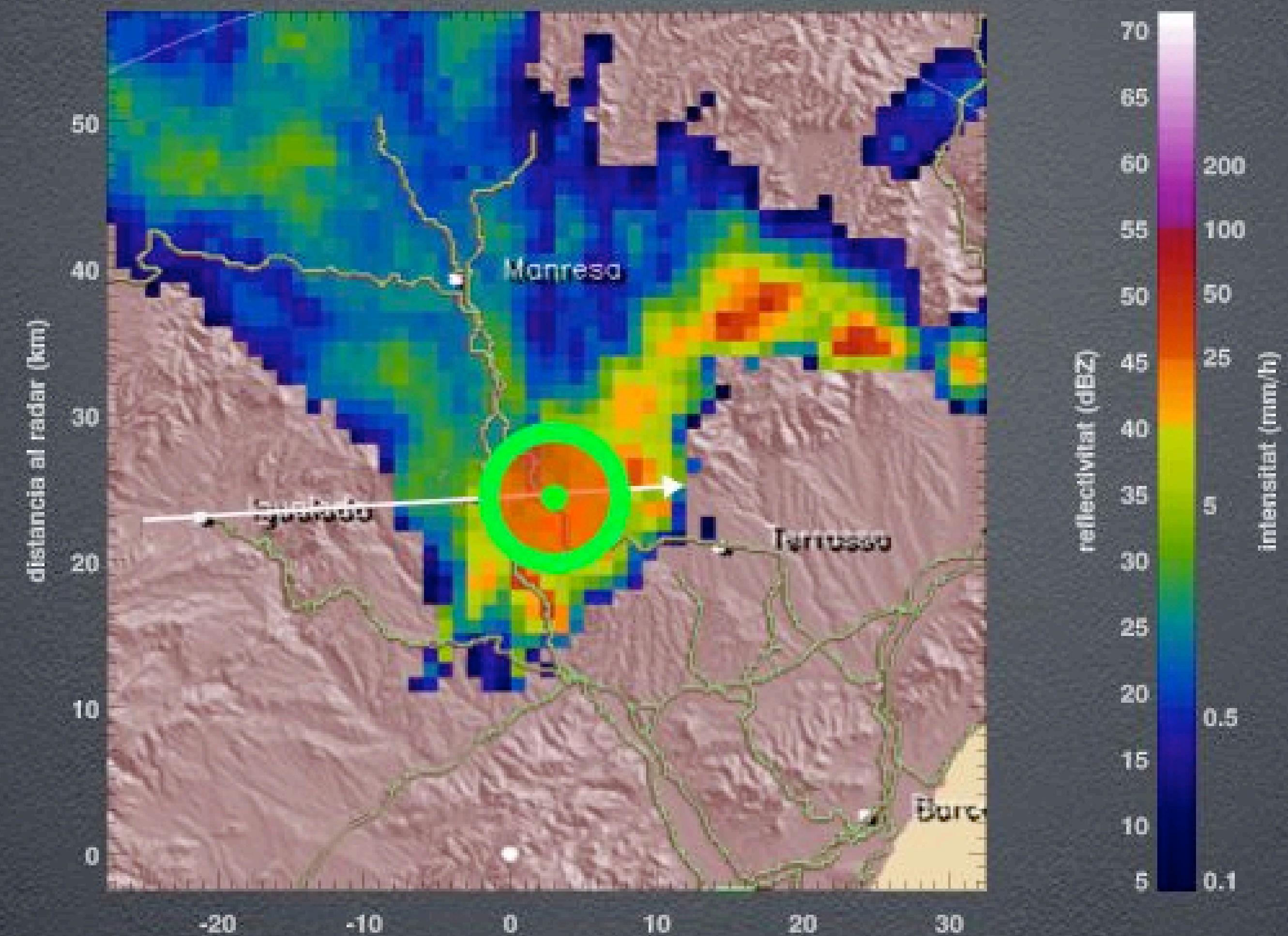
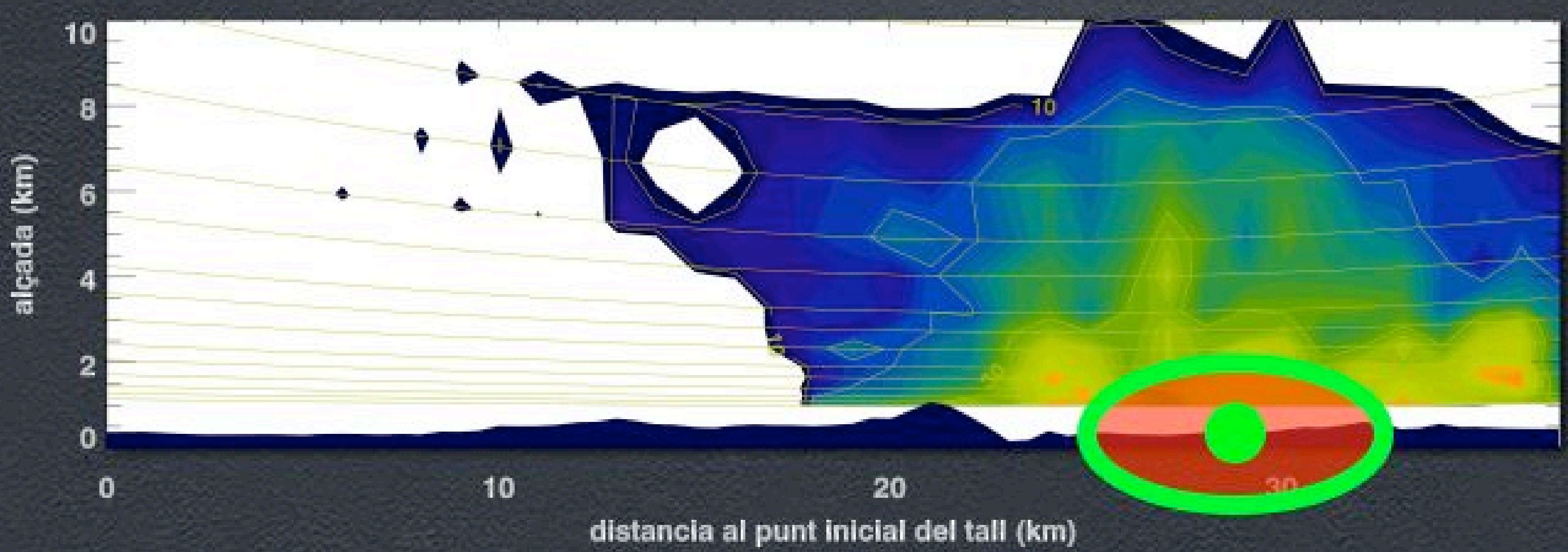
distancia al radar (km)
reflectivitat (dBZ)
intensitat (mm/h)


alçada (km)
distancia al punt inicial del tall (km)

22:30





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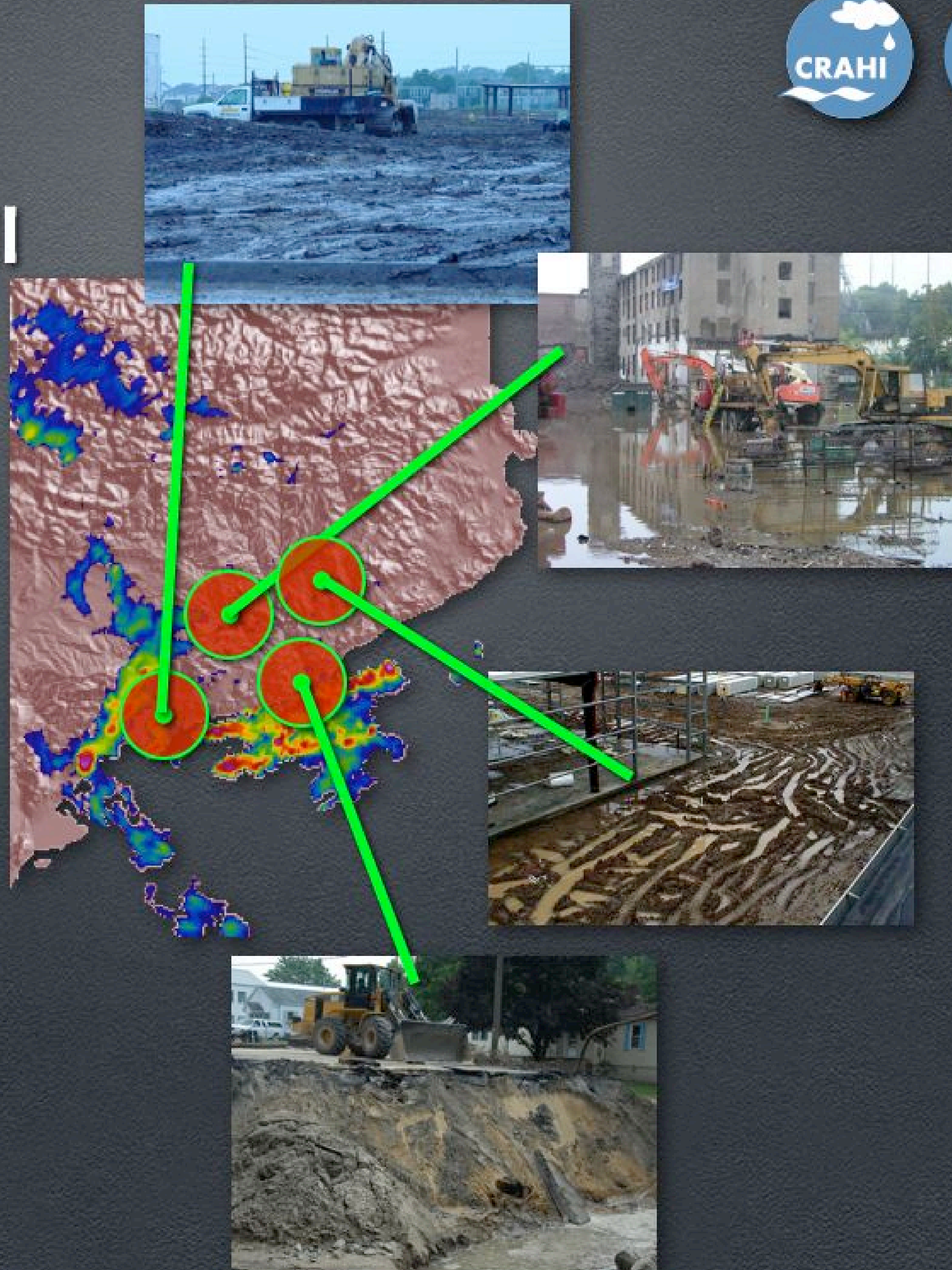
Hazard identification based on rainfall forecasts



EU radar mosaic

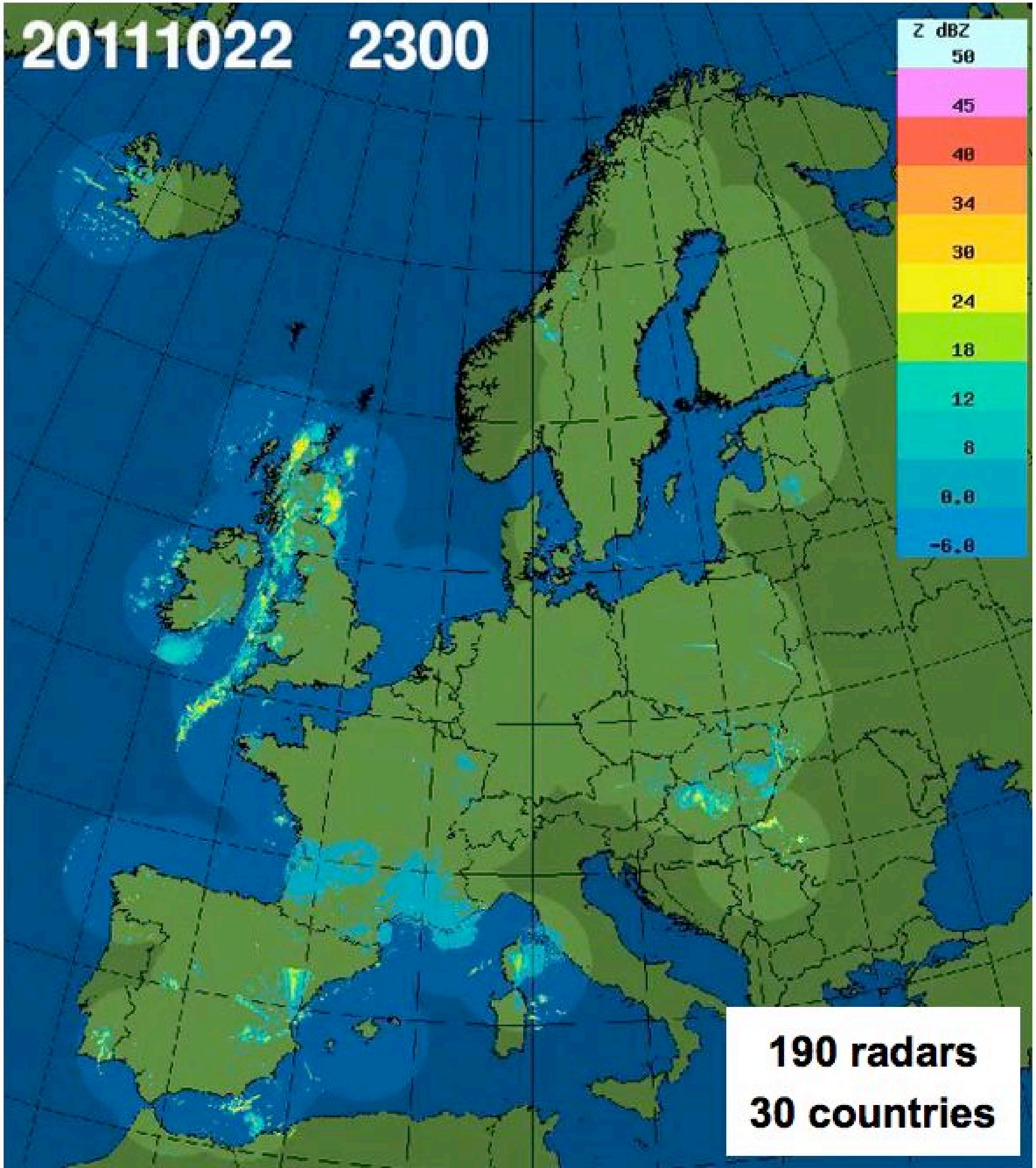
OPERA
EIG EUMETNET PROGRAMME

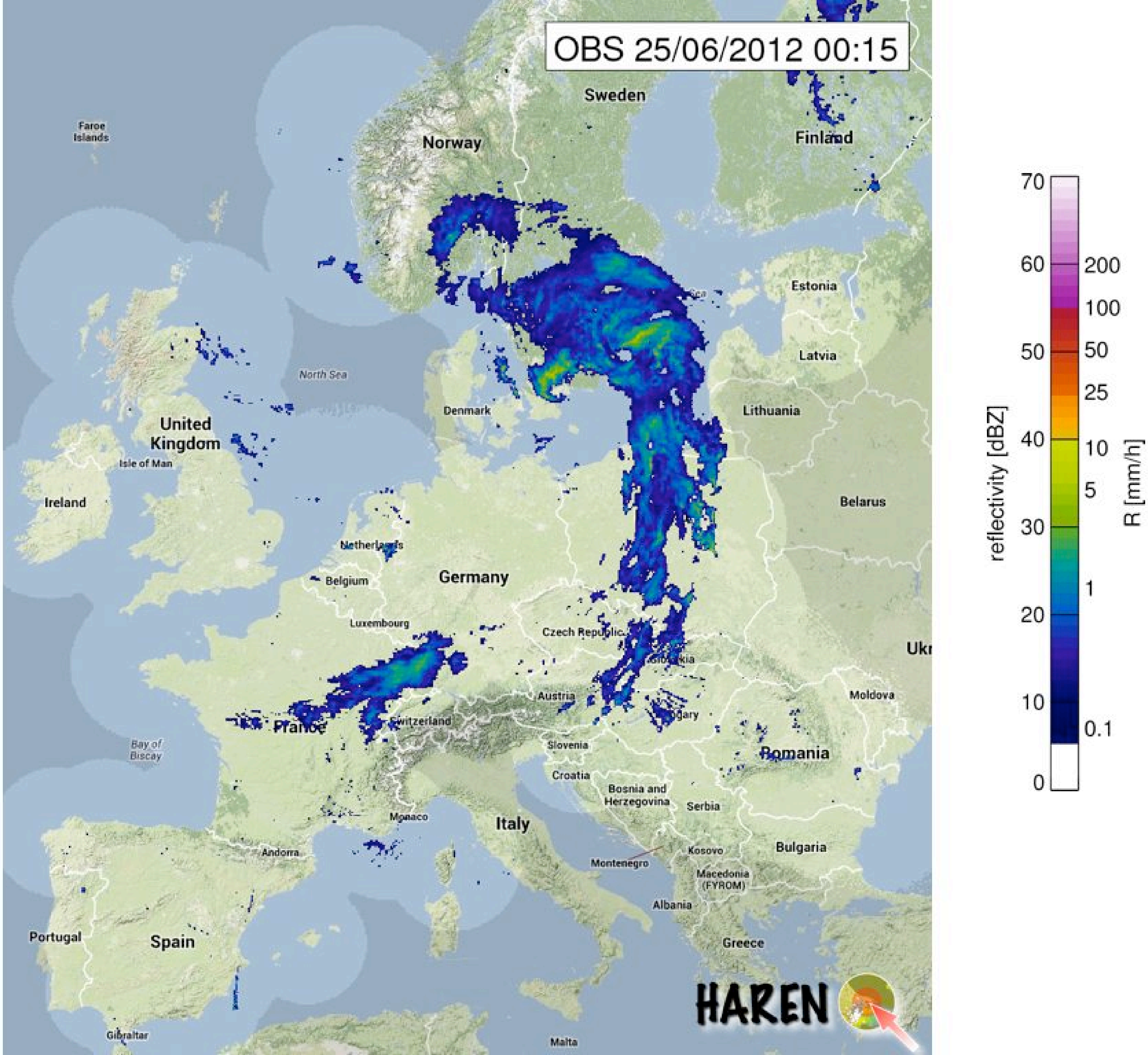
OPERA radar mosaic:

- Precipitation observations over Europe @2 km and every 15 minutes.
- Operationally produced since mid 2011.
- Nowcasting demonstration: **since June 2012**

HAREN

European Civil Protection




OBS 25/06/2012 00:15
Sweden
Norway
Finland
Faroe Islands
Estonia
Latvia
Lithuania
North Sea
Denmark
United Kingdom
Isle of Man
Ireland
Belarus
Netherlands
Belgium
Germany
Luxembourg
Czech Republic
Ukr
Moldova
Austria
Switzerland
France
Bay of Biscay
Slovenia
Romania
Croatia
Bosnia and Herzegovina
Serbia
Monaco
Italy
Andorra
Kosovo
Bulgaria
Montenegro
Macedonia (FYROM)
Albania
Portugal
Spain
Greece
Gibraltar
Malta
HAREN
reflectivity [dBZ]
R [mm/h]
70
60
50
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30
20
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200
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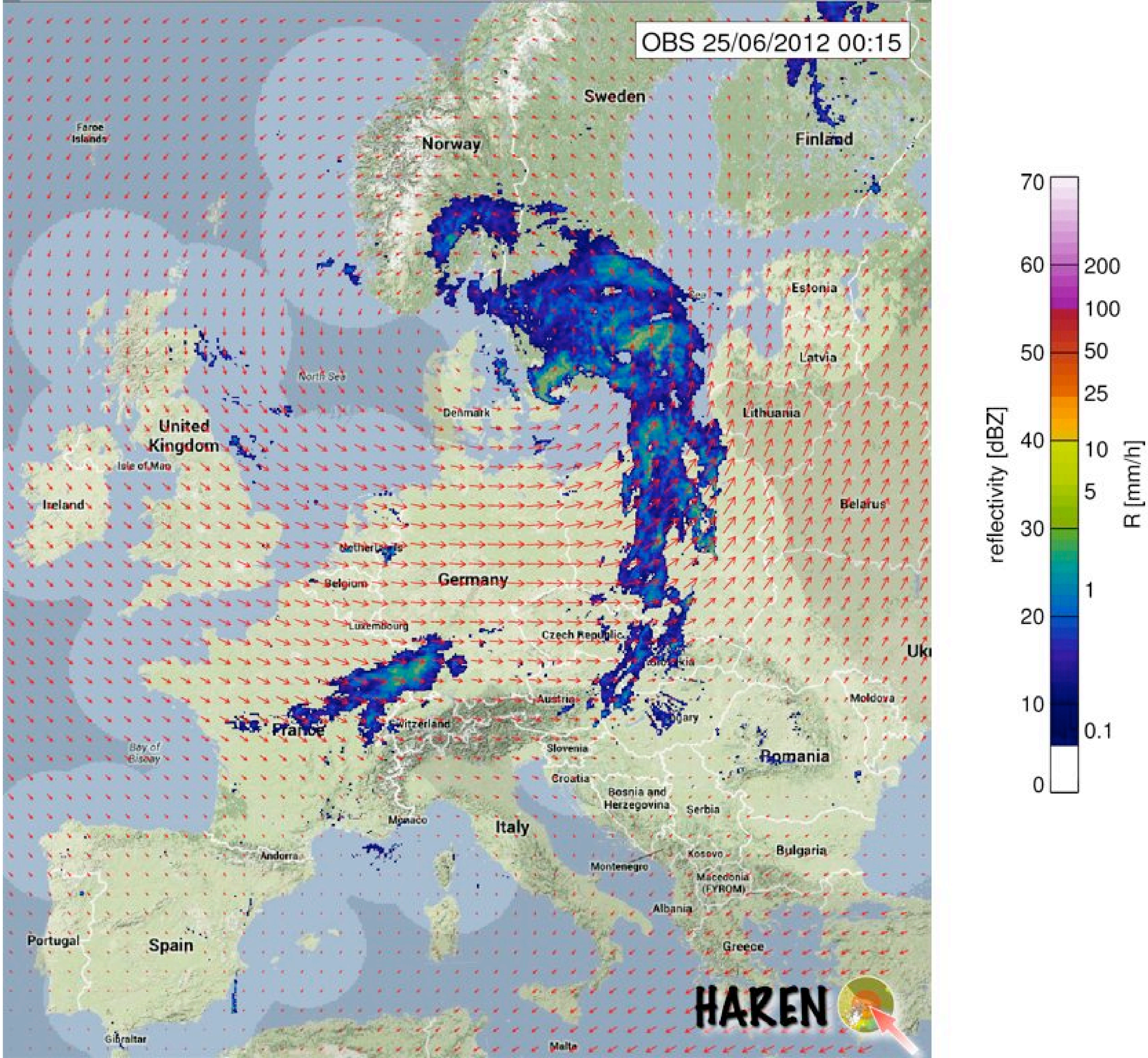
1
0.1

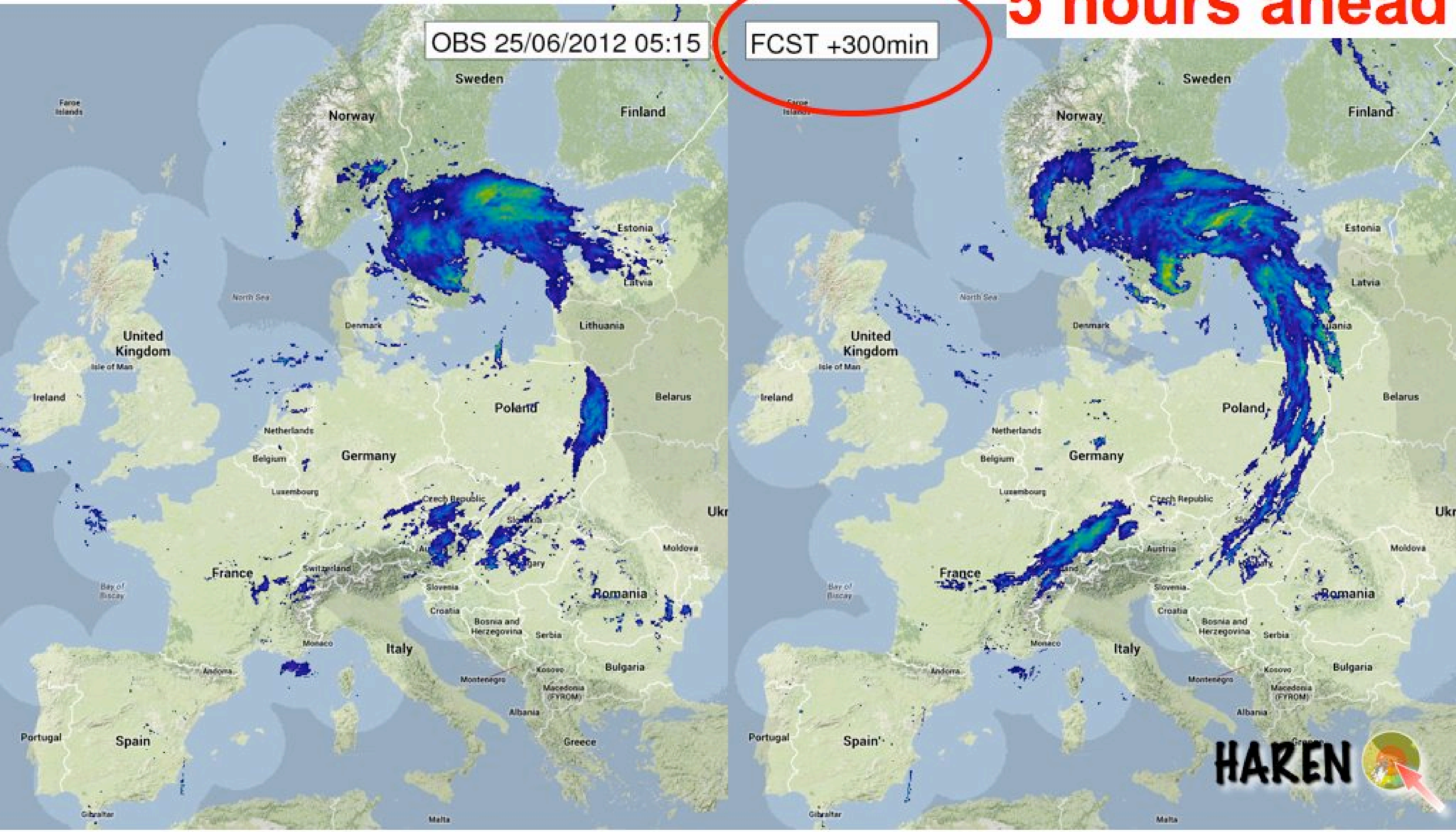


OBS 25/06/2012 00:15
Sweden
Norway
Finland
Faroe Islands
Estonia
Latvia
Lithuania
North Sea
Denmark
United Kingdom
Isle of Man
Ireland
Belarus
Netherlands
Belgium
Germany
Luxembourg
Czech Republic
Slovakia
Ukr
Moldova
Austria
Hungary
France
Switzerland
Slovenia
Romania
Bay of Biscay
Croatia
Bosnia and Herzegovina
Serbia
Monaco
Italy
Andorra
Kosovo
Bulgaria
Montenegro
Macedonia (FYROM)
Albania
Portugal
Spain
Greece
Gibraltar
Malta
HAREN
reflectivity [dBZ]
R [mm/h]
70
60
50
40
30
20
10
0
200
100
50
25
10
5
1
0.1

European Radar Nowcasting - OPERA mosaics

Over a network of 150+ radars.

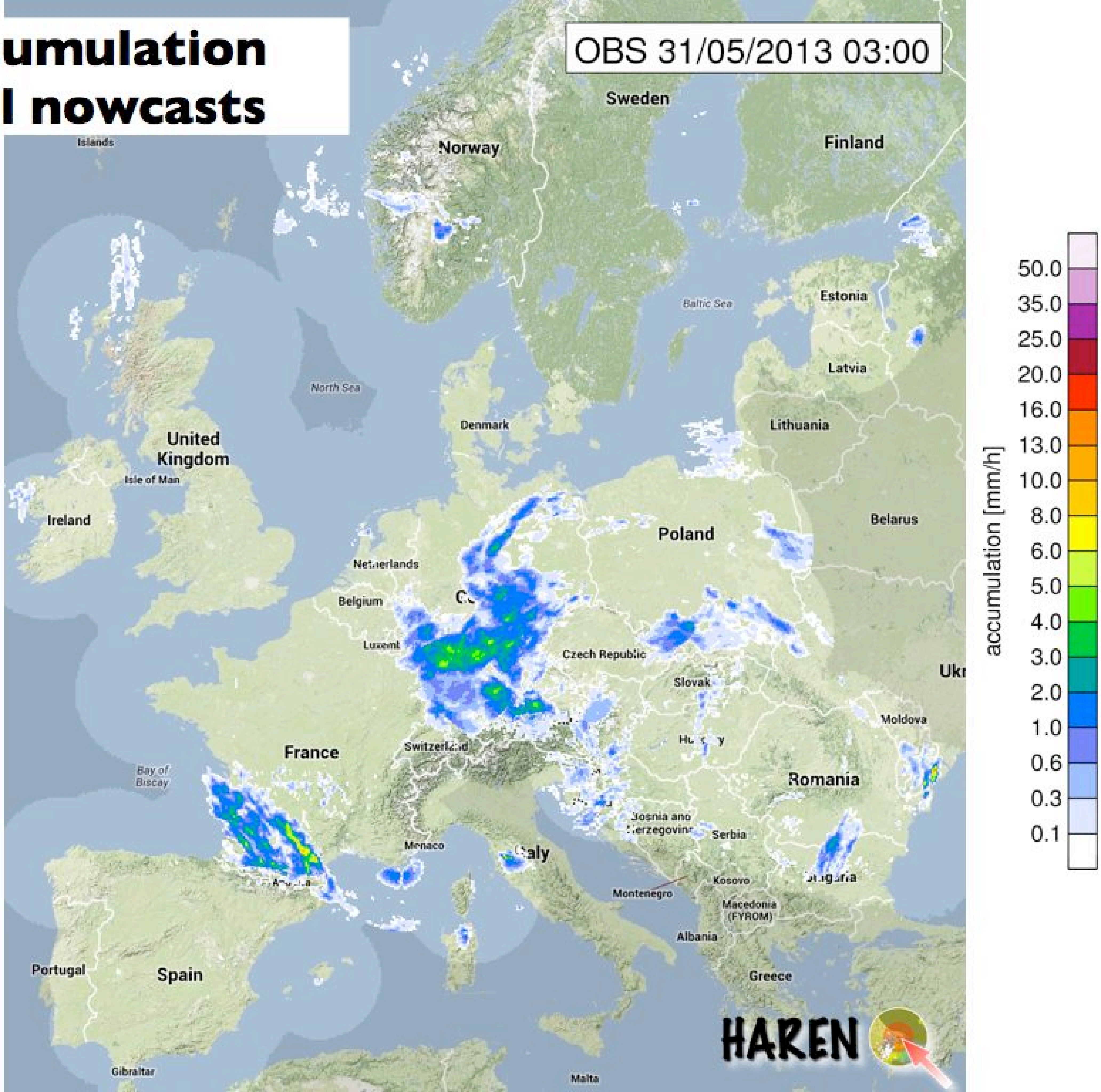
5 hours ahead



CRAHI Algorithm of nowcasting by lagrangian persistence

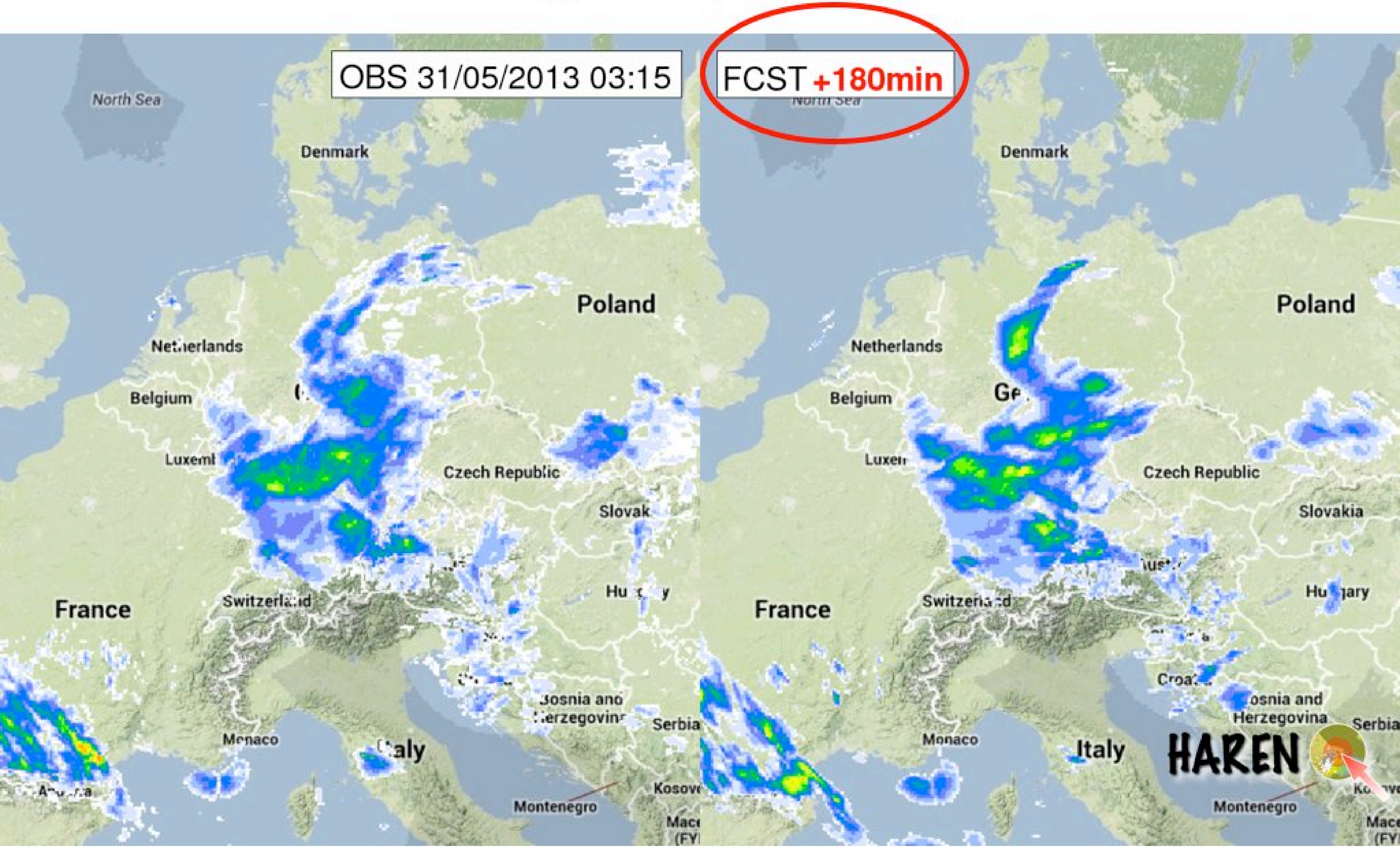
Berenguer et al. J. Hydrometeorology, 2005; J. of Hydrology, 2011

1h-accumulation rainfall nowcasts



1h-accumulation rainfall nowcasts

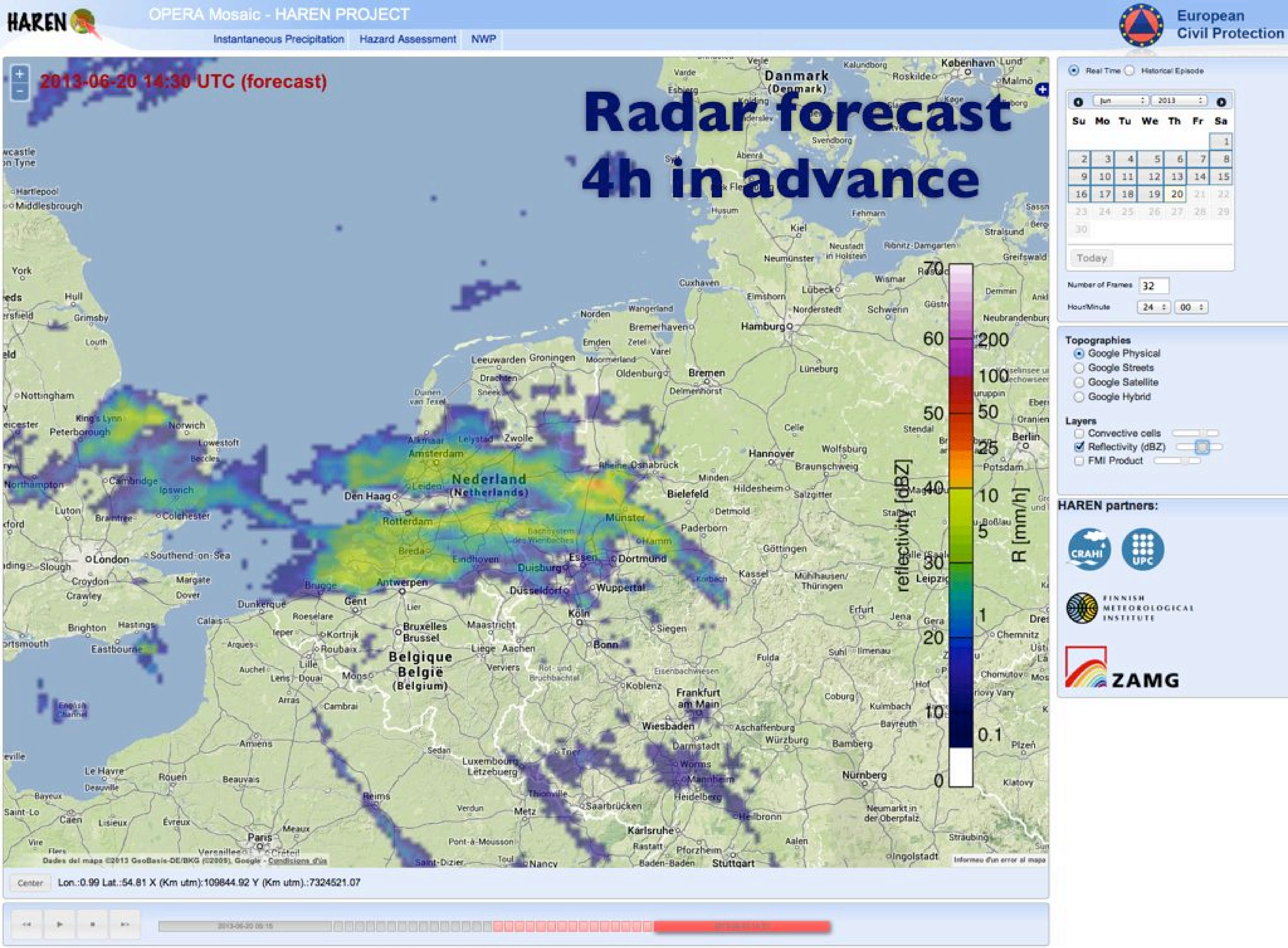
Nowcasts @ 31 May 2013 3h ahead



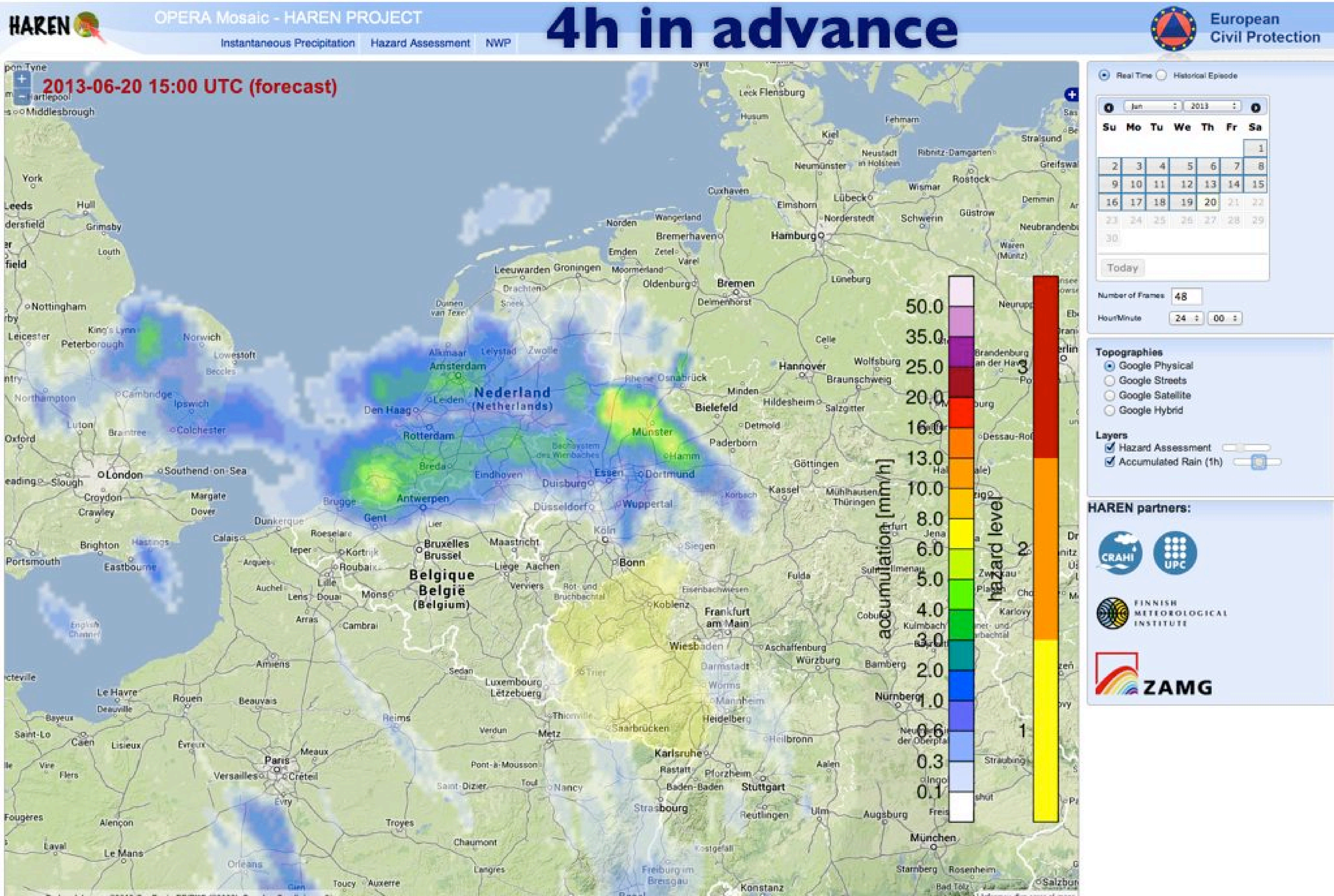
CASE STUDY in The Netherlands (20 June 2013)

Ondertussen in het oosten van het land: zandzakken en rubberbootjes

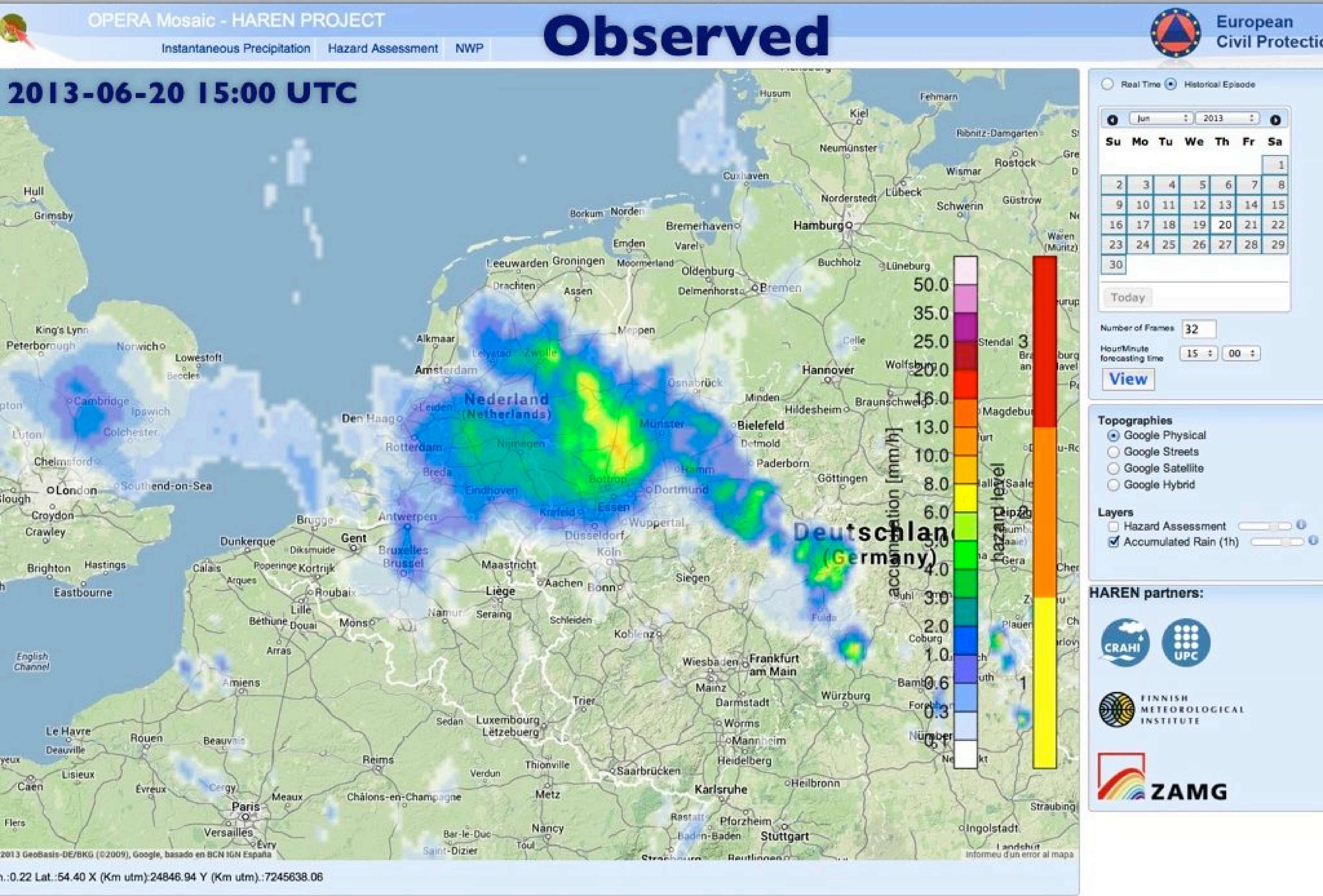
Noodweer in Enschede. Screenshot van WeerGroningen.


HAREN
OPERA Mosaic - HAREN PROJECT
Instantaneous Precipitation
Hazard Assessment
NWP
European Civil Protection
2013-06-20 14:30 UTC (forecast)
Radar forecast
4h in advance
Real Time
Historical Episode
Su Mo Tu We Th Fr Sa
Today
Number of Frames 32
Hour/Minute 24 00
Topographies
Google Physical
Google Streets
Google Satellite
Google Hybrid
Layers
Convective cells
Reflectivity (dBZ)
FMI Product
HAREN partners:
CRAHI
UPC
FINNISH METEOROLOGICAL INSTITUTE
ZAMG
reflectivity [dBZ]
R [mm/h]
70
60
50
40
30
20
10
0
200
100
50
25
10
5
1
0.1
Center
Lon.:0.99 Lat.:54.81 X (Km utm):109844.92 Y (Km utm):7324521.07

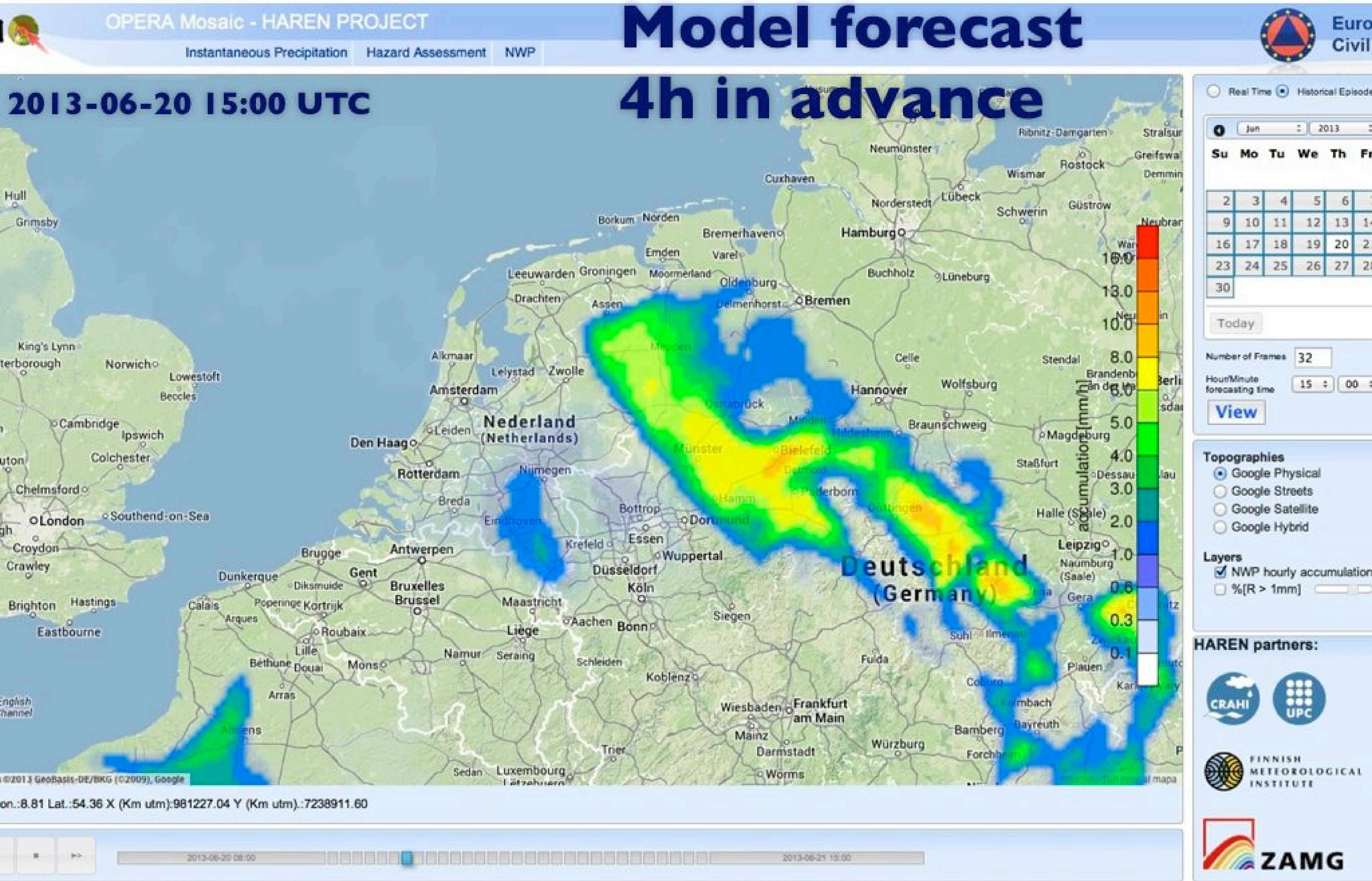
1h Radar Accumulation 4h in advance



1h Radar Accumulation Observed



Model forecast 4h in advance



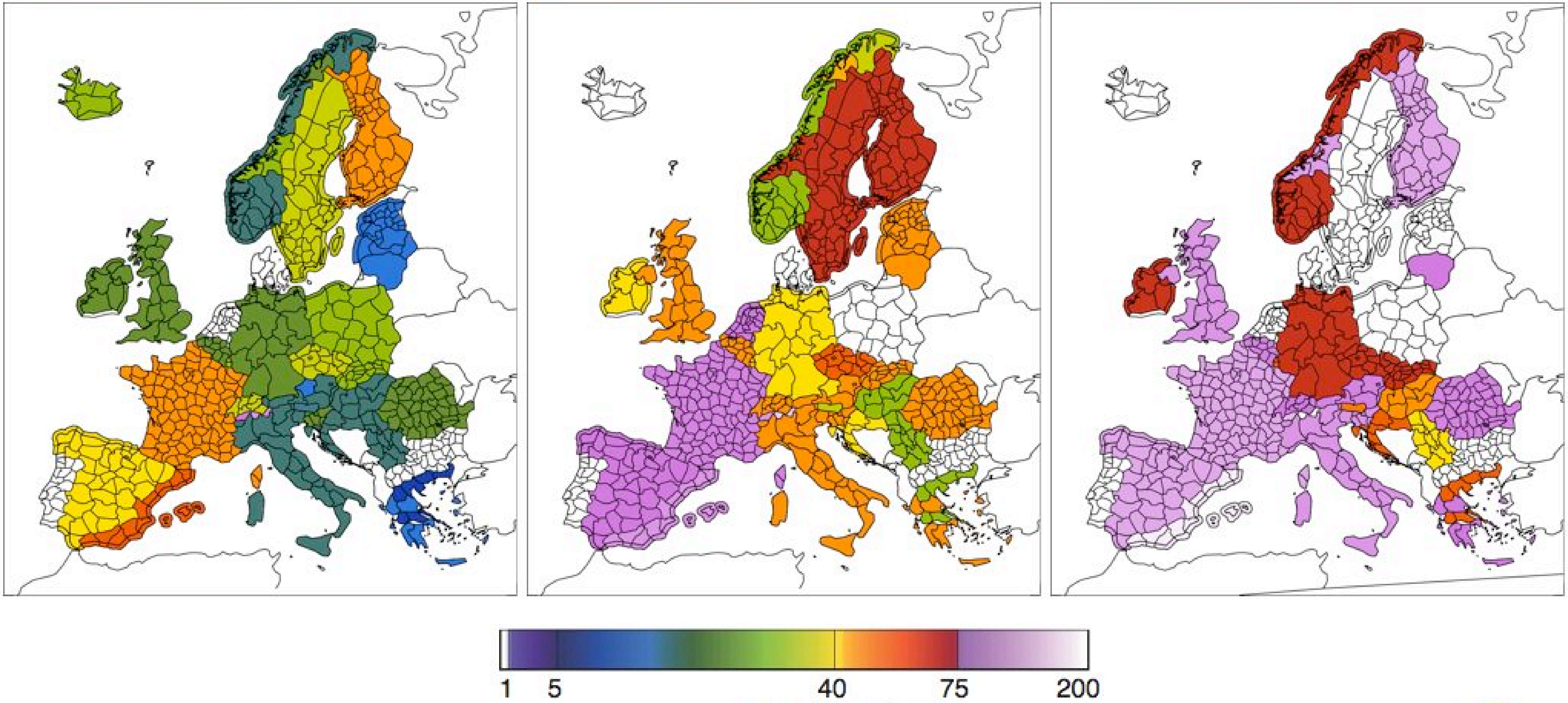
HAZARD ASSESSMENT

regional thresholds for 12-h accumulations defined by METEOALARM

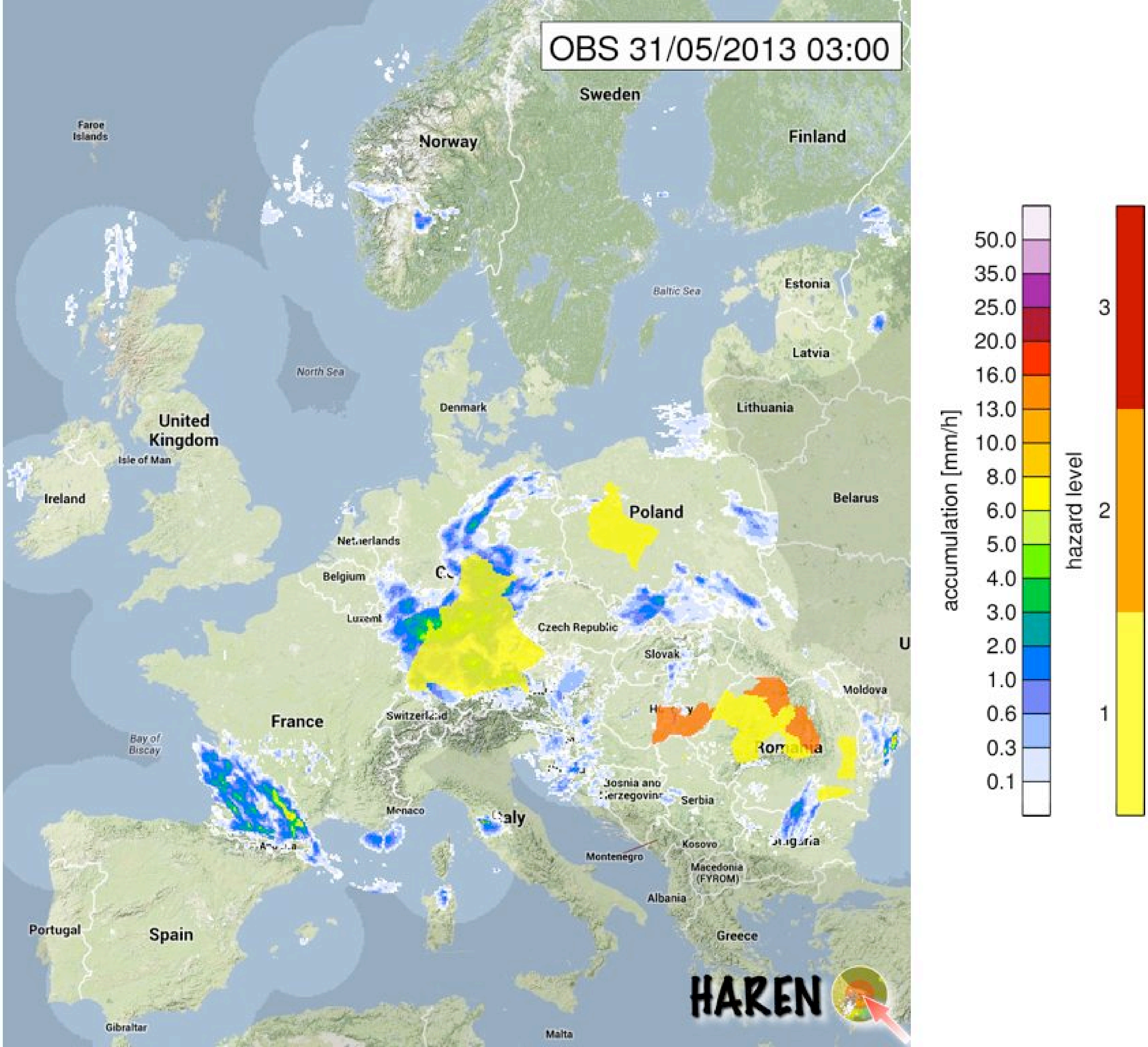
hazard level 1

hazard level 2

hazard level3

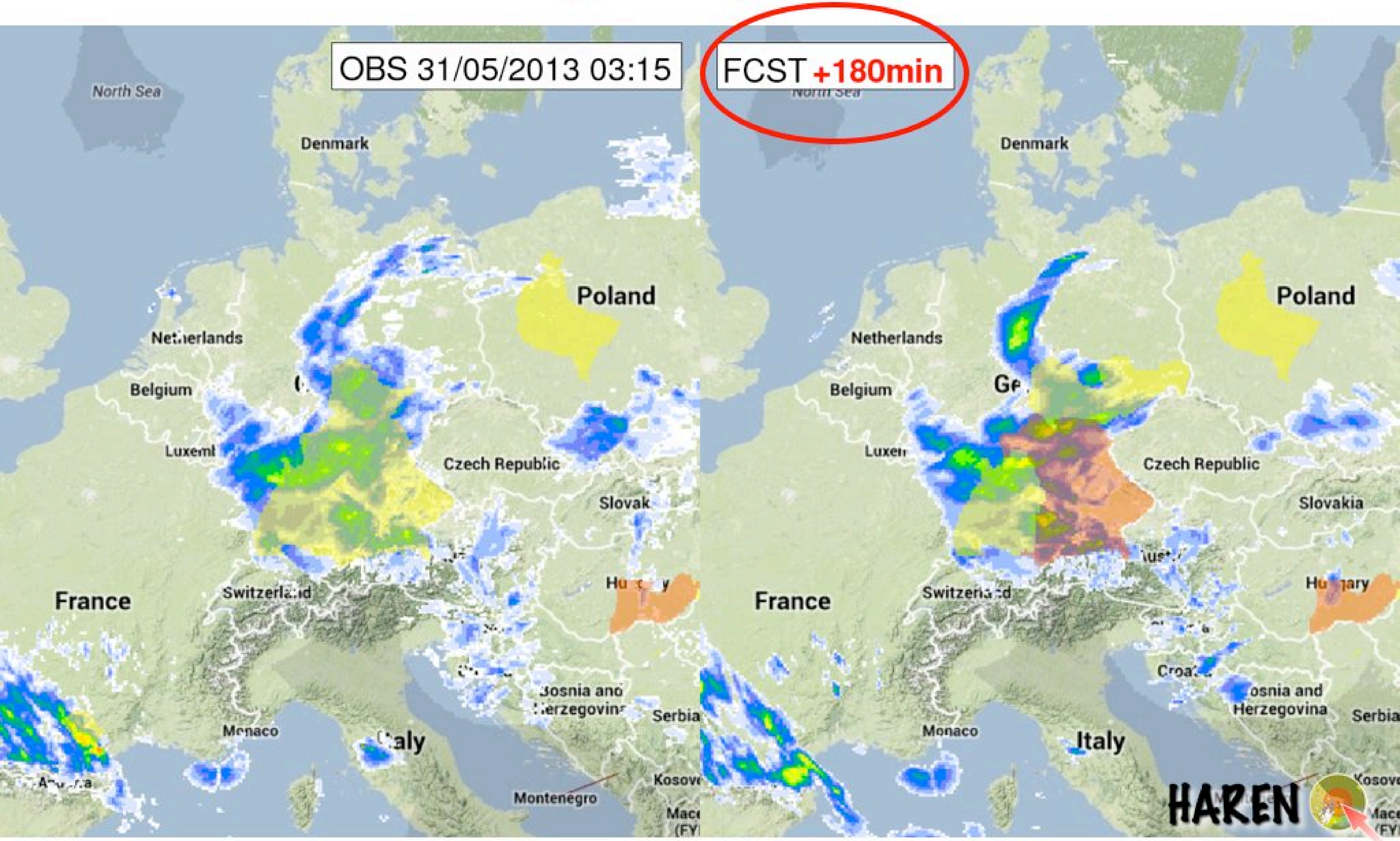


HAREN


OBS 31/05/2013 03:00
Sweden
Norway
Finland
Faroe Islands
Estonia
Baltic Sea
Latvia
North Sea
Denmark
Lithuania
United Kingdom
Isle of Man
Ireland
Belarus
Poland
Netherlands
Belgium
Czech Republic
Slovak
Moldova
France
Switzerland
Romania
Bay of Biscay
Bosnia and Herzegovina
Serbia
Monaco
Italy
Kosovo
Montenegro
Macedonia (FYROM)
Albania
Portugal
Spain
Greece
Gibraltar
Malta
HAREN
accumulation [mm/h]
50.0
35.0
25.0
20.0
16.0
13.0
10.0
8.0
6.0
5.0
4.0
3.0
2.0
1.0
0.6
0.3
0.1
hazard level
3
2
1

Hazard assessment based on 1h rainfall accumulations

Nowcasts @ 31 May 2013 3h ahead

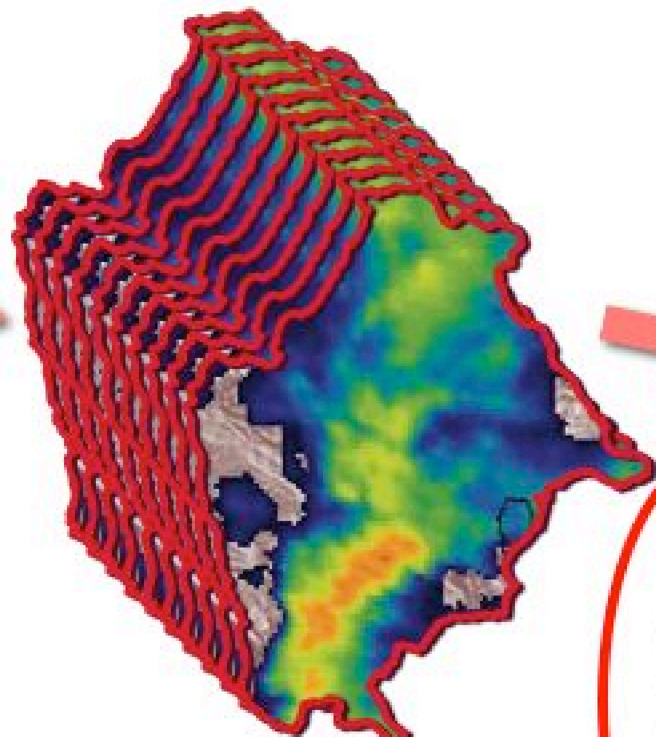


FF & DF early warning systems

IMPRINTS

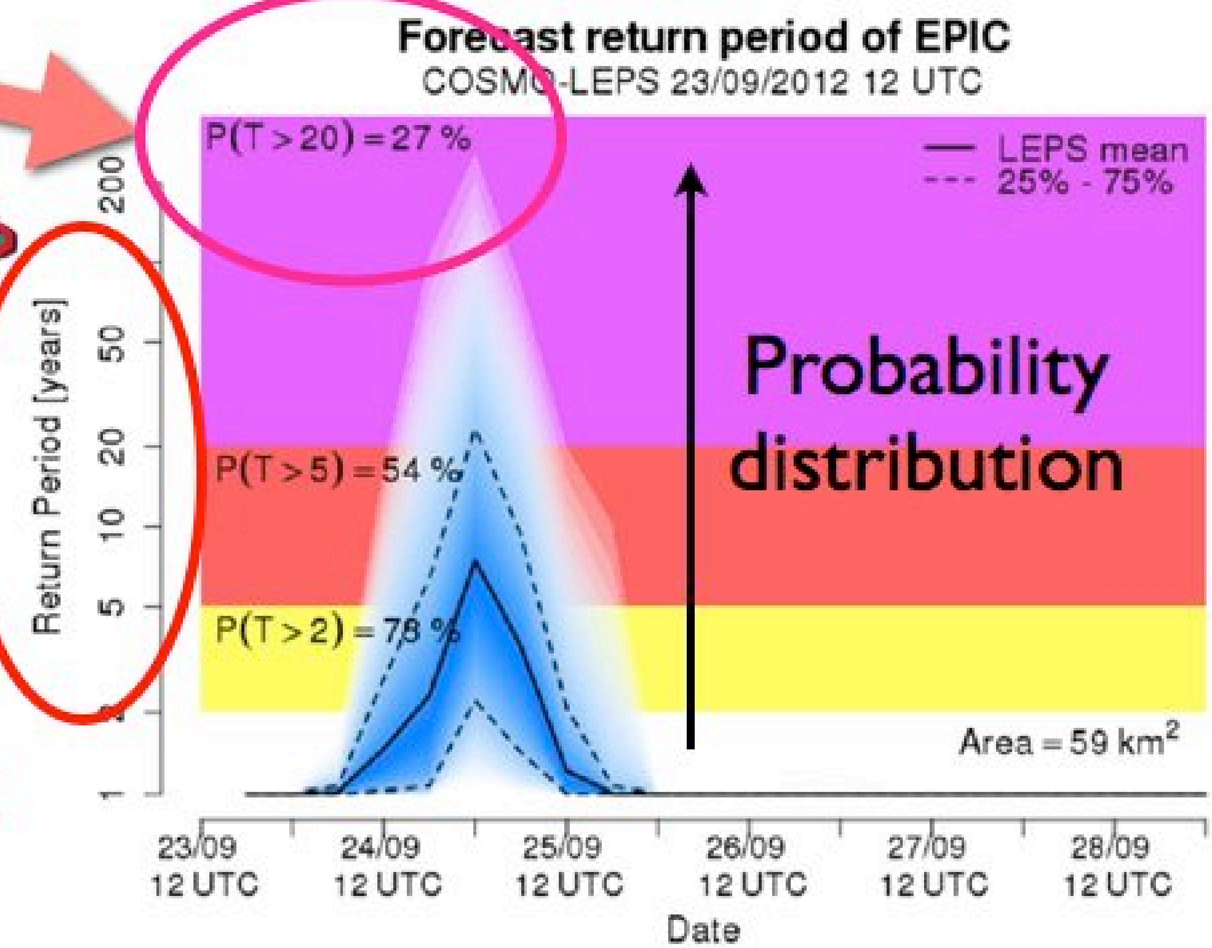
EDHIT Radar
Rainfall forecasts

Probabilistic basin
aggregated rainfall
forecasts



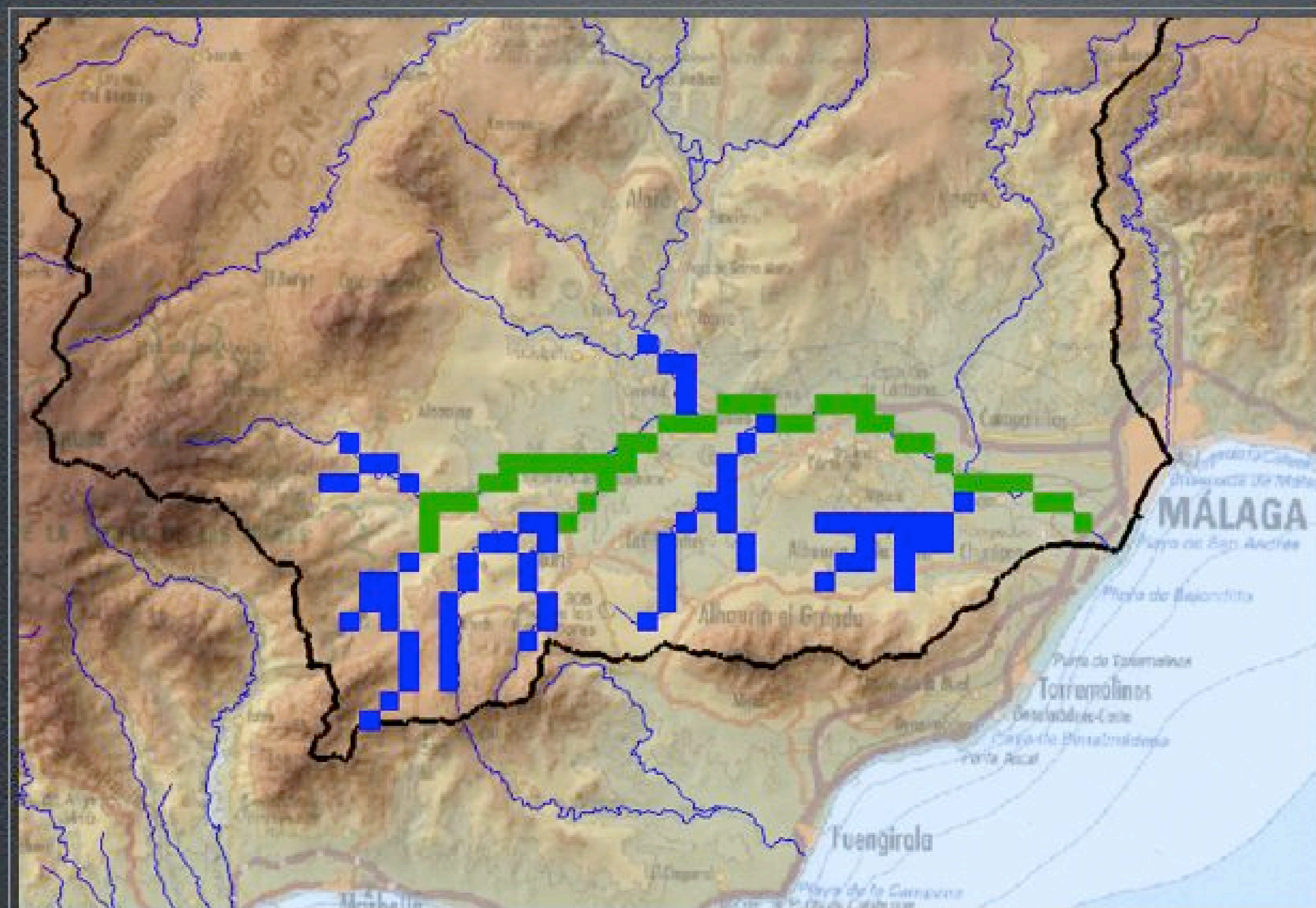
Return Period of any
member calculated by
comparison against EPIC
climatology

Warning code associated
to the 75% percentile
member



IMPRINTS FF & DF early warning system

- Probabilistic Early Warning System **based on the probability of basin-aggregated rainfall excedences**



Guadalhorce basin (Malaga) 16/02/2010

Example of
PFFGS 1 km
Source: CRAHI

Flood Warning

Exceeded Return Period T(years)

Course on tools to support the EU Flood Directive implementation on for Flash Flood prone areas

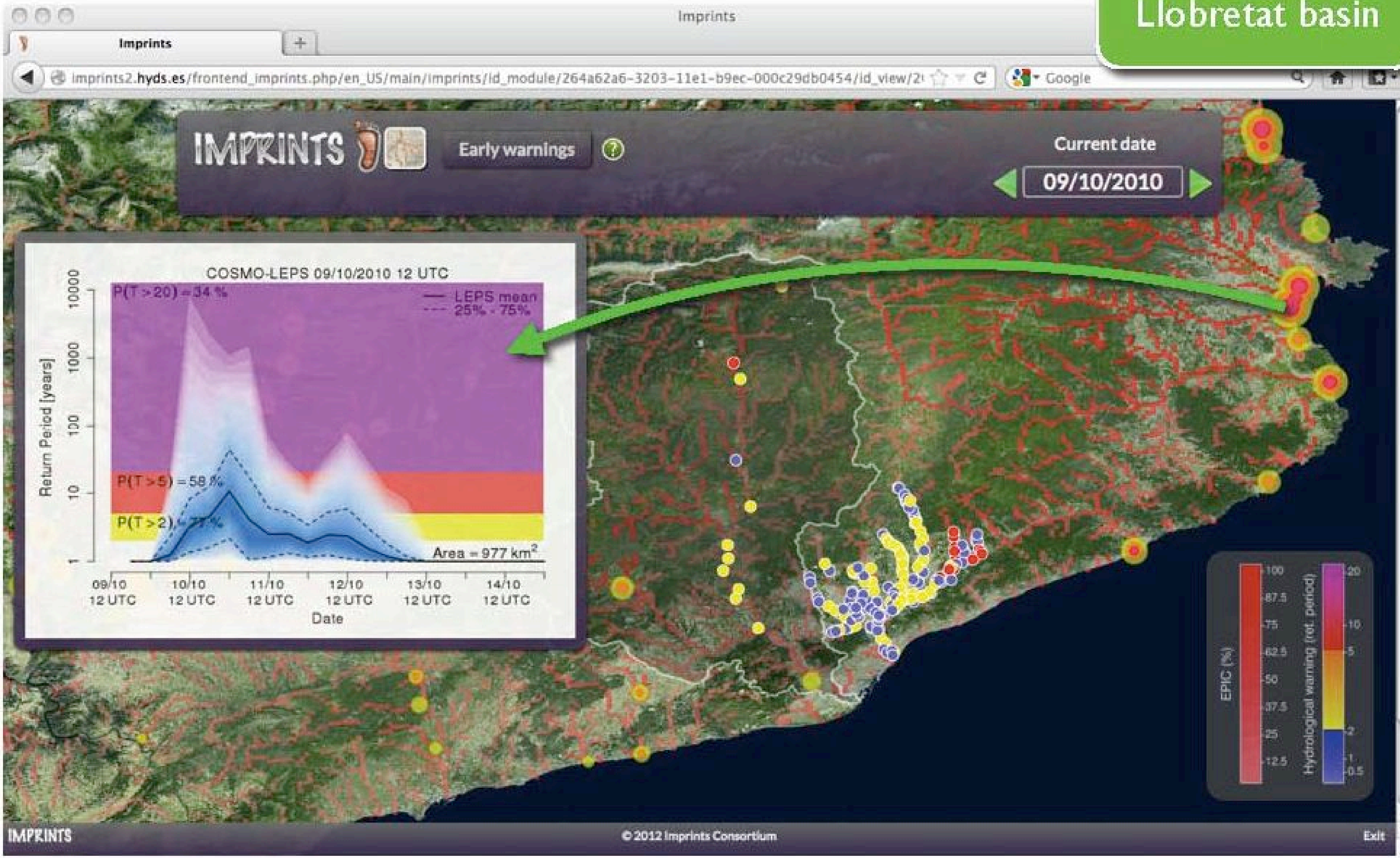
IMPRINTS

Early warnings (1-6 days in advance)

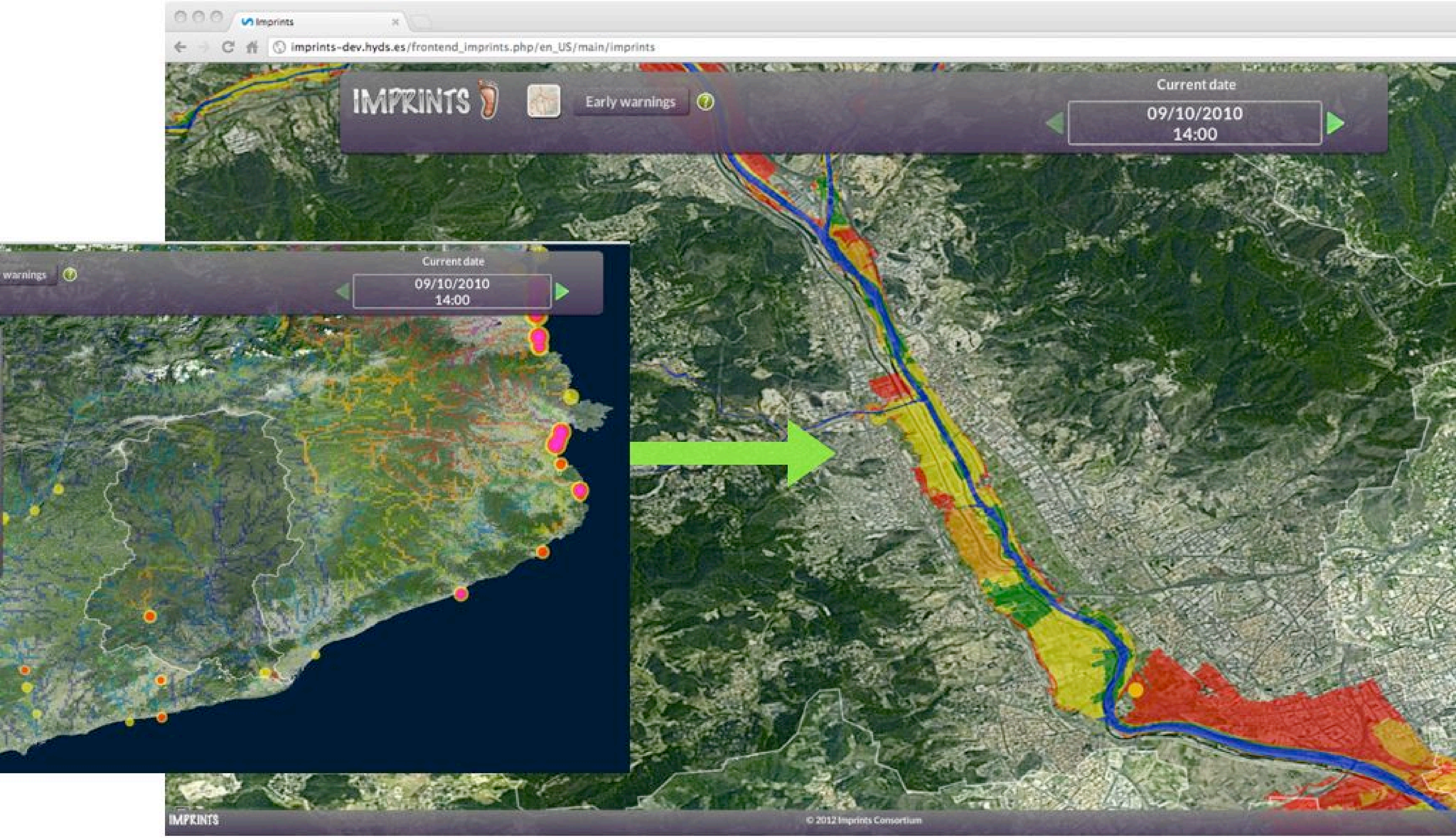
6-10 October
Llobretat basin

Early warnings (1-6 days in advance)

6-10 October
Llobretat basin

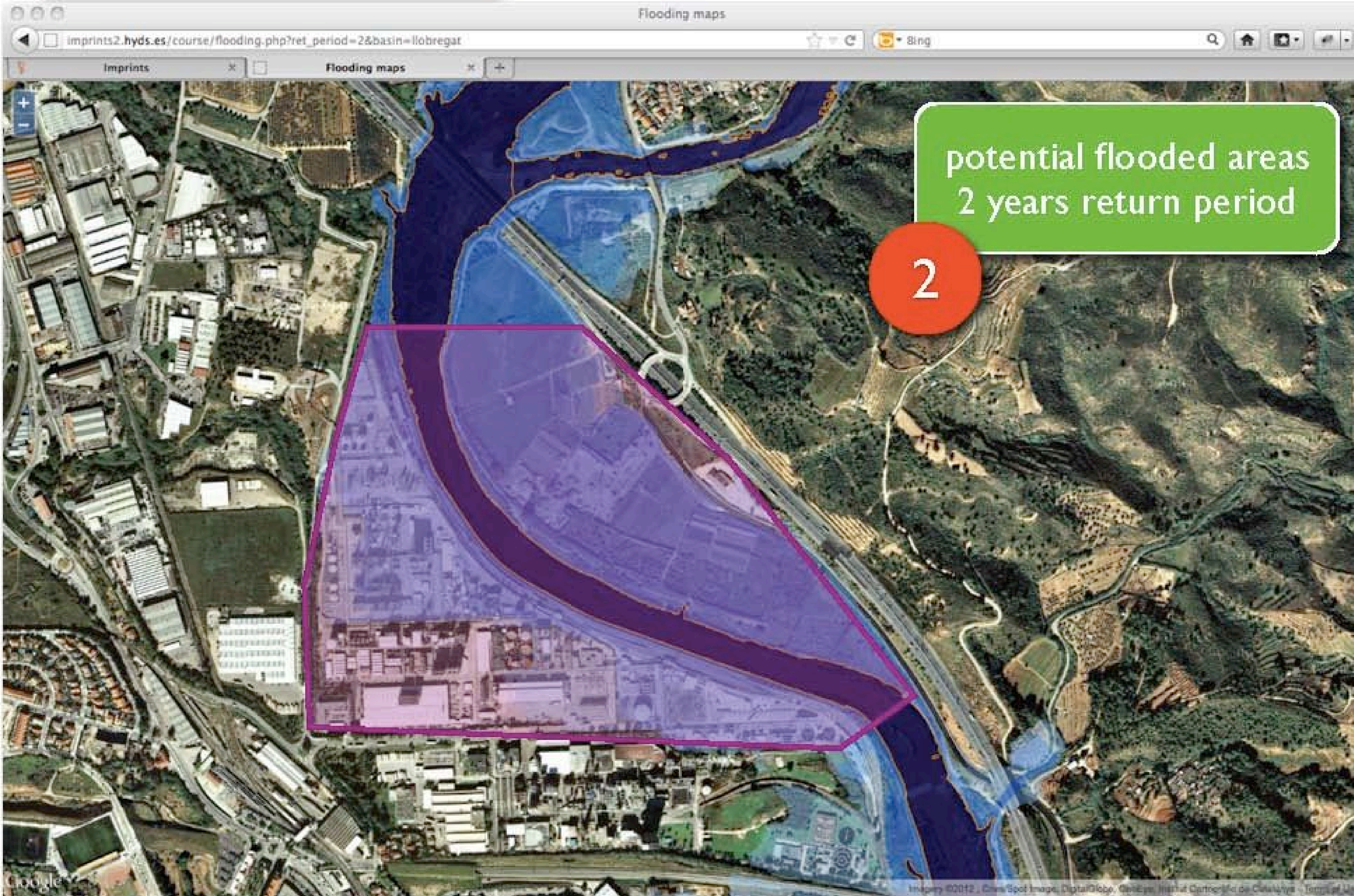


Warnings at basin scale 10/10/2010

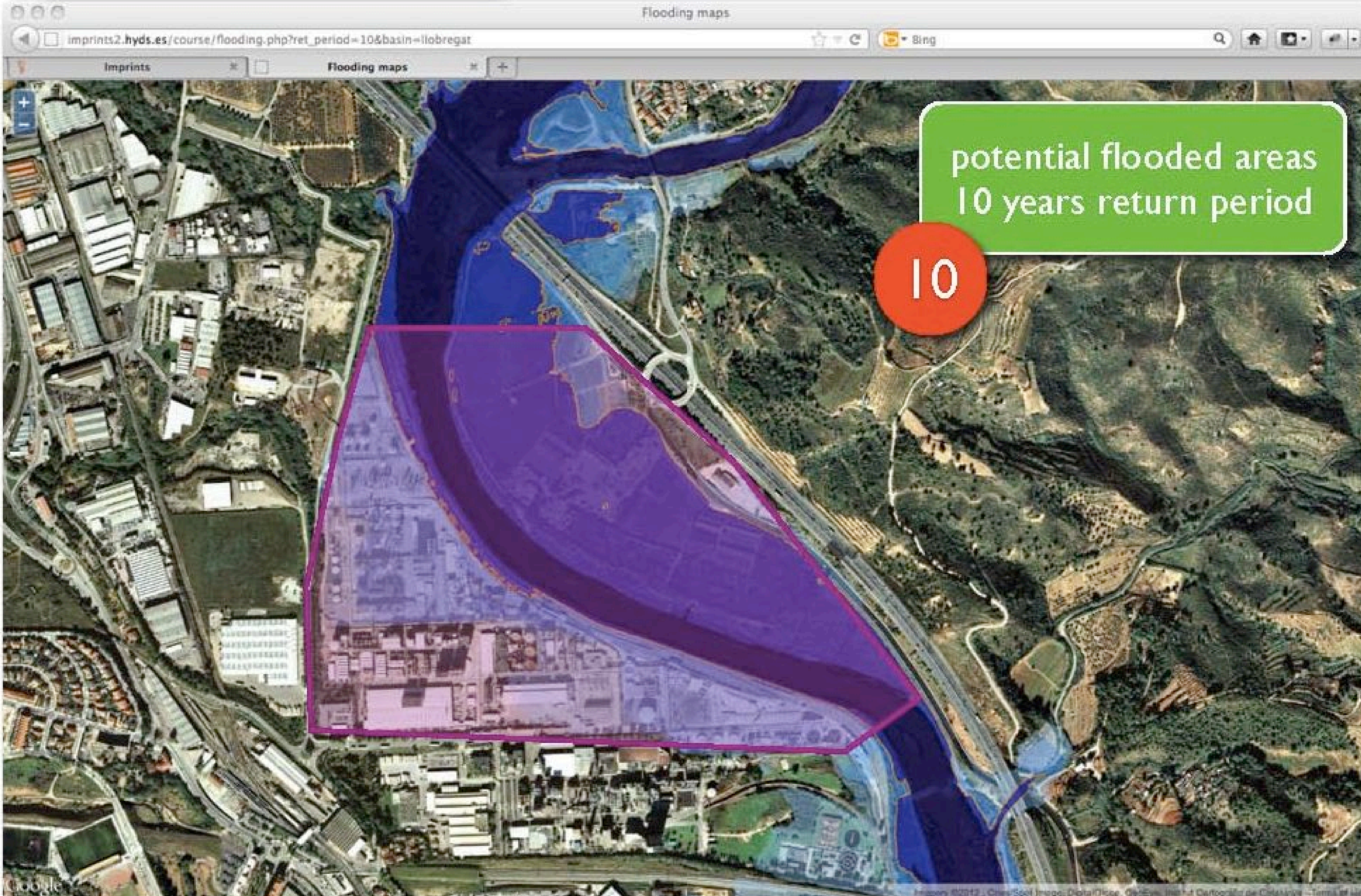


crossed with vulnerability and risk maps IMPRINTS

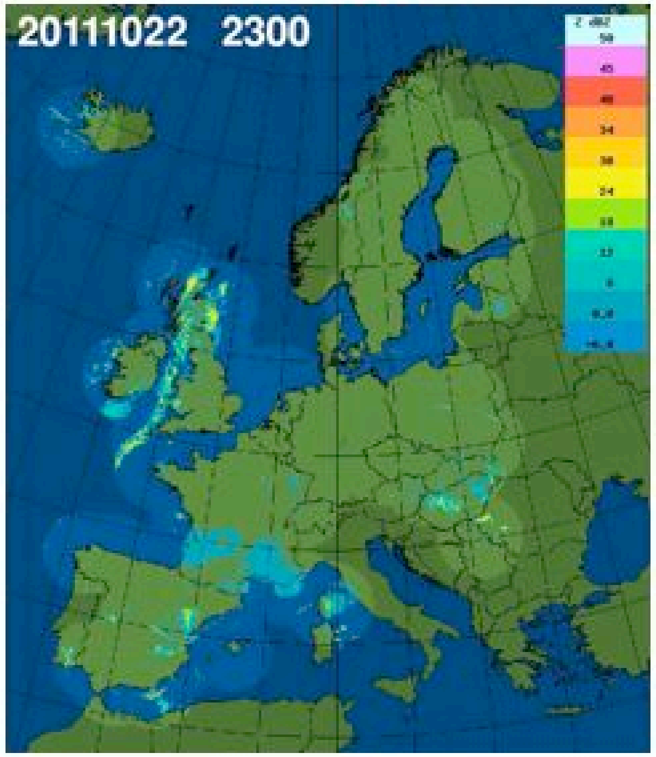
Critical points



Critical points



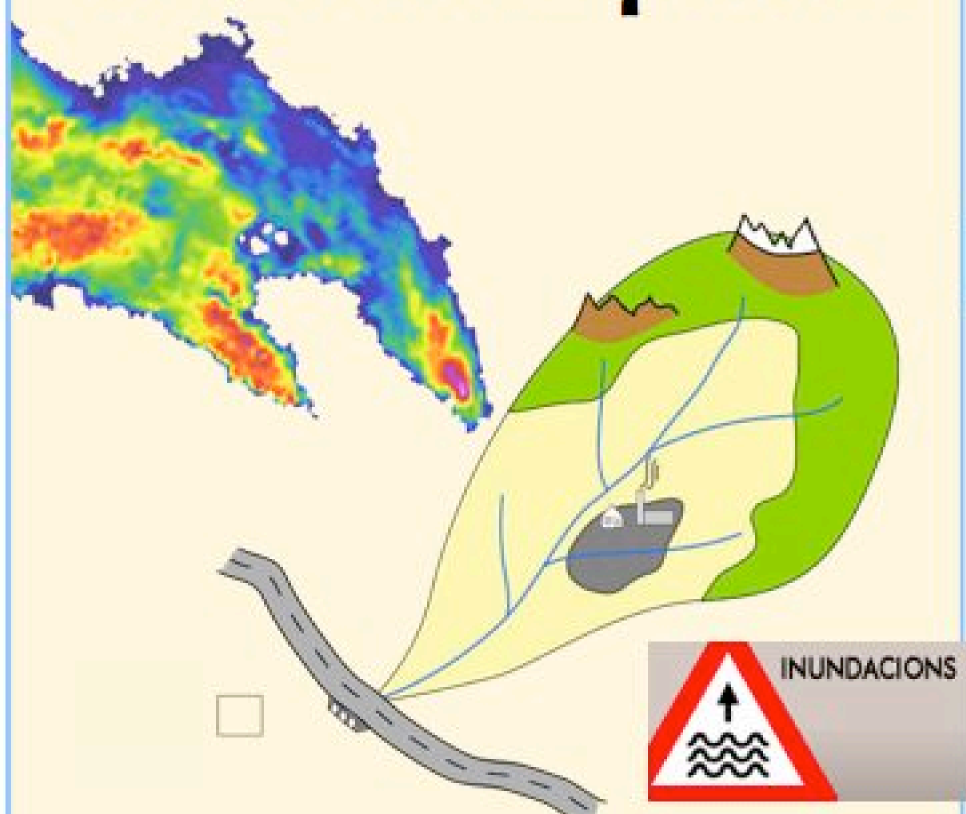
From observations

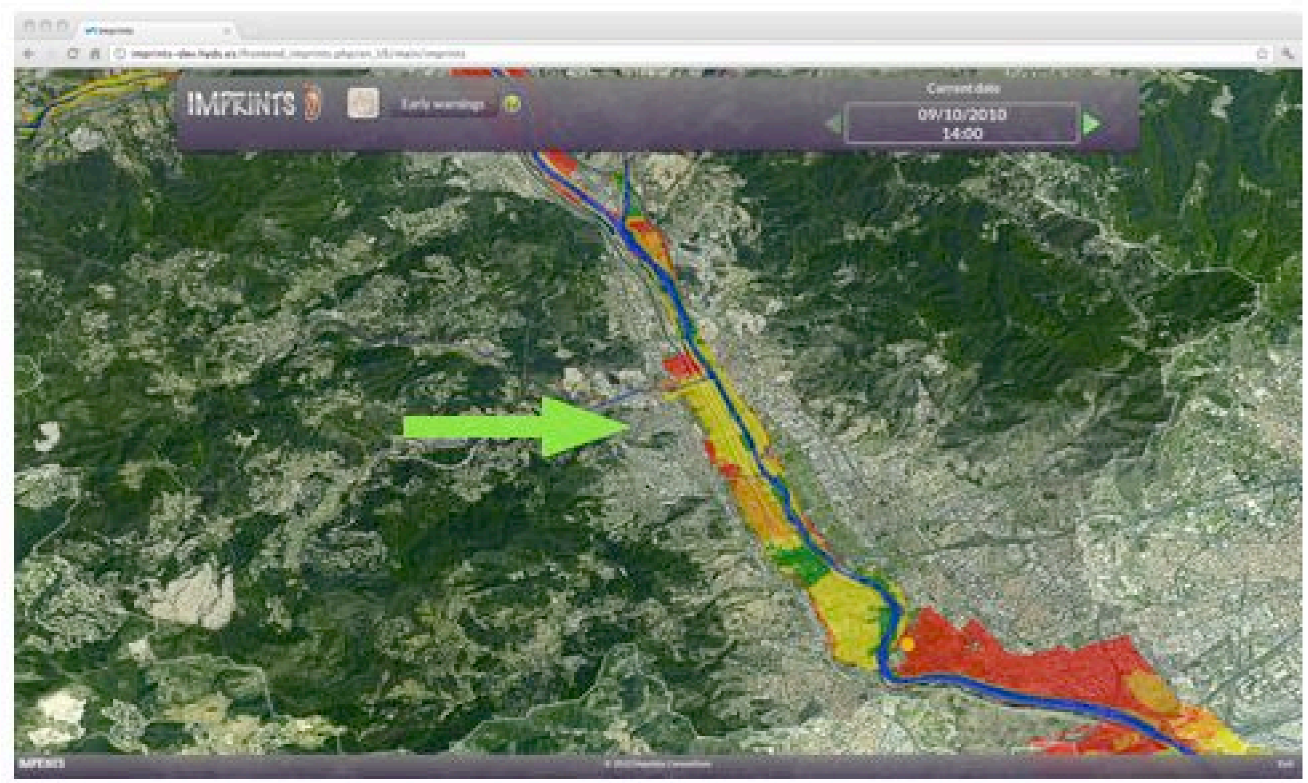


EDHIT

High resolution rainfall nowcastings over Europe @2km every 15 minutes

Hazard anticipation at sensitive points





Cross them with vulnerability maps

Advanced real-time hydrometeorological warnings

Because tools are just tools

what you really need is **people**

well trained brilliant people